Amos Ellmaker

# THE

# Emporium

OF

ARTS & SCIENCES.

Vol. 1.


Conducted by

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Philadelphia Published by

JOSEPH DELAPLAINE.

THE

# EMPORIUM

OF

## ARTS AND SCIENCES.

# PROSPECTUS

OF

# THE EMPORIUM

OF

# ARTS AND SCIENCES.

In the present state of society, it would, beyond a doubt, be considered a work of supererogation, to point out the connexion of human happiness with an extension of knowledge. If knowledge be thus eminently beneficial, is it not our interest, as it assuredly is our duty, to promote its diffusion amongst us? It is a fortunate circumstance, that we rarely find so great a degree of ignorance in our extensive territory, as exists in many regions much older in the annals of history; on the contrary, it is remarkable, that notwithstanding the scattered state of our population, our citizens are better informed and have fewer prejudices than any people upon the globe. Liberty, the surest pledge of free inquiry, is one prime source of the advantages we enjoy. Unfettered in our press—unshackled in our conscience, man here possesses means of happiness as perfect as is consistent with his nature. From the same cause, no doubt, in part arises that ingenuity which is so conspicuous in the American character. Few nations can boast of more improvements in labour-saving machinery, than have been discovered in the progress of the mechanical arts amongst us. We are, however, but young in practical information on numerous

points, in which our highest interests are concerned. To aid our researches, we still require that solid information arising out of extensive operations and experience, which European cotemporaries are continually affording.

Let it not be said, we have the books amongst us from which these treasures may be culled! To be extensively useful, they must be widely disseminated; but this is not to be effected by a few imported copies. Our own presses must diffuse their contents, or they will continue to perish upon the shelves of individuals, or in our public libraries! Independently too of this consideration, much foreign matter, useless to our country, adds greatly to the expense of the imported works in question.

France, that imperial Colossus, has evinced by her present existence, the truth of the maxim, that "Knowledge is power." At the period in which she was threatened with the inroads of foreign enemies, her means of defence were poured in profusion from domestic sources into her lap, by the skilful operations of a few scientific men. Nitre, the chief constituent of the means of war, was abundantly formed by their directions, when all foreign sources were completely dried up: And to this period, the greater part of her powder is supplied from the products of her own soil.—How long did the scientific operations of Archimedes baffle the attacks of the veteran bands of Rome! Surely, then, reason and sound public policy will dictate the encouragement of a diffusion of knowledge, on which, perhaps, at some future day, the very destinies of our country may depend.

The Emporium professes to be a source of *practical information in the various branches of scientific research,* and is intended to convey the rich harvest of *facts,* con-

tained in foreign valuable papers on *Chemistry, Mineralogy, Natural Philosophy, Arts, Sciences,* and *Agriculture,* with the proper cultivation of which, undoubtedly the truest interests of every country, but especially our own, are closely connected.

We might expatiate, largely, on the great utility of such a work, but this would be unnecessary, since our numerous artists and manufacturers will readily perceive that they may derive from it the plainest and easiest means to lessen labour and unnecessary application. In some it will awaken reflection on a favourite pursuit; new sources of industry and emolument will be pointed out to others, and the practical knowledge of many will receive improvement and unexpected aid. Standing, as it were upon the shoulders of our transatlantic rivals, we may hope to catch new views of the prospect before us, which will enable us to shorten the road to ultimate perfection.

In this work, Science, which is of no party, will equally distribute her favours to all. It is avowedly a work of practical utility, in which all are equally concerned. Its object is to make that ours, which may subserve both public and private interest. To practical information all other objects are merely secondary; speculative opinions will therefore as seldom as possible be obtruded.

A selection will appear in the Emporium, which will render it a kind of *text book* to our citizens, and which, if successfully continued, it is hoped will prove a valuable library of useful knowledge to every class of society.

Although what has been mentioned will form the prominent features of our publication, it is intended likewise

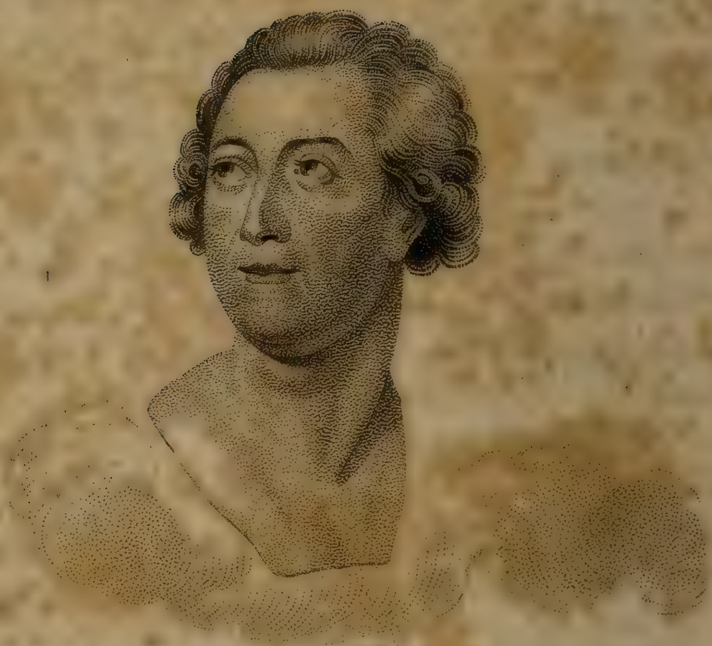
to preserve on its pages, such insulated facts as may hereafter prove useful. Miscellaneous observations of practical tendency, together with several minor, though not uninteresting subjects of information, will, it is expected, afford a repast to all persons who feel interested in the advancement of science.

Notwithstanding it is designed principally to attend to the progressive state of science in Europe, from whence we must reasonably look for information for many years to come, yet original papers of our country of real merit, and of practical tendency, will at all times be cheerfully received, and promptly communicated to the public.

Of the manner in which this work will be conducted, it becomes the Editor to be silent. Industry will not be wanting, if health permits. Of the labour attending it, he is in some degree qualified to judge, from having conducted a periodical work on medicine to the extent of several volumes. It is his intention to persevere in this undertaking as long as he may be favoured with public patronage, and if he can through it contribute to the interests of his country, his fondest wishes will be accomplished.

JOHN REDMAN COXE.

*Philadelphia, April 1, 1812.*



Anthony Laurence Lavoisier.

Born August 26th 1743. Guillotined May 8th 1794.

THE

# EMPORIUM

OF

# ARTS AND SCIENCES.

VOL. I.] MAY, 1812. [No. 1.

The following communication to Mr. Nicholson is so well adapted to the present work, that it may serve the purpose of a more diffuse and laboured Introduction. EDITOR.

## No. 1.

## *On the utility of Scientific Periodical Publications—In a Letter to Mr. Nicholson.**

DEAR SIR,

THE advantages derived from scientific periodic publications, are an acquisition which former philosophers were not possessed of; and it was not until the last century they were first instituted. The rapid progress of science and information since that period, would be a sufficient argument in favour of their decided utility, without any reference to systematic treatises published, of undoubted merit, and sanctioned by universal approbation.

To the active and ingenious mind in early life this mode of information is invaluable. Besides furnishing new ideas to the young student, they point out the pre-

* Philosophical Journal, vol. 13. p. 72.

cise state of the different branches of human knowledge; they teach him the necessary caution for conducting experiments with vigour and accuracy, instead of drawing conclusions from a few insulated analyses, or imagining that his data are sufficiently perfect for establishing new systems. By reading these publications it is that he will enlarge his general conceptions, and will learn to emulate the various illustrious characters of all the enlightened countries of the world. In these treatises his views will not be confined to one object, but he will contemplate a scene continually varying. The physiology and phenomena of the animal and vegetable kingdoms; the actions and re-actions of the different elementary substances in nature, and their combinations with each other, will pass in succession under his observation.

The great physical laws which constitute and maintain the equilibrium of the world, are inserted in respectable works of this nature as they are discovered and demonstrated, while the errors of former philosophers are detected and exposed; by which means he has an opportunity of ascertaining the value and correctness of those works he may be already in possession of.

To those who consult an Encyclopædia for scientific matter, these publications are of indispensable utility, by continually pointing out the numerous improvements as they become public, and by that means the general system of philosophical knowledge is kept to the level of the existing state of discovery.

To the mechanic a repository of this kind must be highly useful, as the receptacle in which he may record his labours and improvements, and secure to himself the well-earned fame of his discoveries, at the same time that he derives advantage from others following his example in their contributions to the general fund of science.

In short, there is no class of individuals but may profit

from this method of extending useful knowledge. The small sum of seven-pence or eight-pence a week to any economical person is trifling, and there is no doubt but every inquirer will find something of which he may abridge himself, in order to become possessed of such an assemblage of facts and opinions. He is as it were making himself intimate with a class of men whose names will be read with admiration by a grateful posterity. It is only by familiarizing the mind with the sublime objects of science, and diffusing them over the face of the earth, that we can expect to establish that spirit of philanthropy and social order, which is so necessary to the happiness of the human race.

I am, &c. &c.

RICHARD WINTER.

## No. 2.

As many of the papers which will appear in this work, will be derived from the English, French, and other periodical works of the continent of Europe, it becomes necessary, in order to understand the weights and measures, &c. to give the tables, with their corresponding value to those which we usually employ. These tables will with propriety occupy the first few pages of our work, to which reference can be at all times conveniently made. Ed.

### *Of English Weights and Measures.**

THE weights and measures required by the chemist are few and simple, but they should be accurate, and their relative values well defined.

* Aikin's Chemical Dictionary, vol. 2.

For the measure of weight, the Troy pound of 12 ounces, or 5760 grains, is the integer almost always preferred, being that which admits of a minuter subdivision, and whose correspondences with measures of capacity are more accurately defined; though there are still some slight differences in this respect which it were to be wished were removed by authority. The subdivisions of the Troy ounce employed by chemists are sometimes those of Apothecaries weight, that is, the ounce into 8 drams, the dram into 3 scruples, and the scruple into 20 grains, or more commonly, simply into drams and grains; or sometimes the ounce is divided into 20 pennyweights, and the pennyweight into 24 grains. Often the grain is the only integer employed, and sets of weights are used of the different hundreds, tens, and units. The averdupois pound is however sometimes adopted, being the standard of most things bought and sold in common life. It is equal to 7000 grains Troy, and is divided into 16 ounces, and the ounce legally into 16 drams, but the latter division is never used by chemists, being liable to be mistaken for the Troy dram, which weighs more than twice as much.

For measures of capacity, chemists employ both the *ounce measure* (or bulk occupied by the ounce, or any proportion of it, of distilled water at 60°) and the *cubic inch.* For larger quantities both the *Wine Pint,* of 28.875 cubic inches, and the *Ale Pint,* of 35.25 cubic inches, are used. Two pints make a *Quart,* and four quarts make a *Gallon.*

The correspondence between measures of weight and capacity is found by the weight of a cubic inch of water. In this however a slight difference exists, in authorities apparently equally worthy of confidence, which depends partly on the extreme difficulty of constructing instruments of perfect accuracy, and partly on some

slight discrepancy between the standards themselves. The extent of this difference is about half a grain in 253. We have adopted in the following Tables the estimations given by Sir G. Shuckburgh Evelyn, in the 88th vol. of the Philosophical Transactions, corrected in a subsequent paper by Mr. Fletcher, in the 4th vol. of the Philosophical Journal. On this calculation the cubic inch of distilled water at 60° therm. and 29.5 bar. weighs 252.506 grains Troy.

Hence we have the following equations.

| | | | | | |
|---|---|---|---|---|---|
| | | | *Cubic inch.* | | |
| 1 ounce Troy of water at 60° occupies | | | 1.900945 | | |
| | *grs. Troy.* | | *lb. Troy.* | | *lb. Averdu.* |
| 1 Wine pint of water weighs | 7291.11075 | = | 1.26581783 | = | 1.04158725 |
| | *grs. Troy.* | | *lb. Troy.* | | *lb. Averdu.* |
| 1 Ale pint of water weighs | 8900.8365 | = | 1.545284 | = | 1.271548 |
| | *Wine pint.* | | *Ale pint.* | | |
| 1 lb. Troy of water occupies | .7900031 | = | .6471302 | | |
| | *Wine pint.* | | *Ale pint.* | | |
| 1 lb. Averdupois of water occupies | .960073 | = | .7864429 | | |

We may here notice the very common error of estimating a wine pint of water to be equal to 16 ounces Troy, since it wants as much as 389 grs. of 16 ounces, when the cubic inch is estimated at 252.506 grs. and 375 grs. when the cubic inch is reckoned at 253 grs. which is the highest estimation. Nevertheless as several measuring vessels are thus graduated, and as the adoption of this standard would be extremely convenient, this measurement may be often usefully employed for moderate quantities; but the chemist should then express that he uses the pint of 16 ounces Troy.

## TABLE

For converting Cubic Inches of Water (at 60 Therm. and 29.5 Bar.) into their equivalents in Troy weight.

| *Cub. Inch of Water* | *Troy grs.* | | *oz.* | | *dram* | | *grs.* |
|---|---|---|---|---|---|---|---|
| 1. weighs | 252.506 | = | 0 | : | 4 | : | 12.506 |
| 2. | 505.012 | = | 1 | : | 0 | : | 25.012 |
| 3. | 757.518 | = | 1 | : | 4 | : | 37.518 |
| 4. | 1010.024 | = | 2 | : | 0 | : | 50.024 |
| 5. | 1262.530 | = | 2 | : | 5 | : | 2.530 |
| 6. | 1515.036 | = | 3 | : | 1 | : | 15.036 |
| 7. | 1767.542 | = | 3 | : | 5 | : | 27.542 |
| 8. | 2020.048 | = | 4 | : | 1 | : | 40.048 |
| 9. | 2272.554 | = | 4 | : | 5 | : | 52.554 |
| 1728. (1 cub. foot) | ——— | | 909 | : | 0 | : | 10.368 |

## TABLE

For converting Troy grains, drams, ounces, and pounds of Water into their equivalent Cubic Inches.

| *Grain* | | *Cubic Inch* |
|---|---|---|
| 1. | = | .00396 |
| 2. | = | .00792 |
| 3. | = | .01188 |
| 4. | = | .01584 |
| 5. | = | .01980 |
| 6. | = | .02376 |
| 7. | = | .02772 |
| 8. | = | .03168 |
| 9. | = | .03564. |

| *Dram* | | *Cubic Inch* |
|---|---|---|
| 1. | = | .237618 |
| 2. | = | .475236 |
| 3. | = | .712854 |
| 4. | = | .950472 |
| 5. | = | 1.188090 |
| 6. | = | 1.425708 |
| 7. | = | 1.663326 |

| *Ounce* | | *Cubic Inch* |
|---|---|---|
| 1. | = | 1.900945 |
| 2. | = | 3.801890 |
| 3. | = | 5.702835 |
| 4. | = | 7.603780 |
| 5. | = | 9.504725 |
| 6. | = | 11.405670 |
| 7. | = | 13.306615 |
| 8. | = | 15.207560 |
| 9. | = | 17.108505 |
| 10. | = | 19.009450 |
| 11. | = | 20.910395 |

| *Pound* | | *Cubic Inch* |
|---|---|---|
| 1 | = | 22.81134 |
| 2 | = | 45.62268 |
| 3 | = | 68.43402 |
| 4 | = | 91.24536 |
| 5 | = | 114.05670 |
| 6 | = | 136.86804 |
| 7 | = | 159.67938 |
| 8 | = | 182.49072 |
| 9 | = | 205.30206 |

## TABLE

For converting Wine Pints of Water into their equivalent Troy and Averdupois Pounds.

| *Wine Pts.* | *lbs. Troy* | *lbs.* | *oz.* | *dr.* | *grs.* | *lbs. Averdu.* |
|---|---|---|---|---|---|---|
| 1. = | 1.26581783 = | 1 : | 3 : | 1 : | 31.1 = | 1.04158725 |
| 2. = | 2.53163566 = | 2 : | 6 : | 3 : | 2.2 = | 2.08317450 |
| 3 = | 3.79745349 = | 3 : | 9 : | 4 : | 33.3 = | 3.12476175 |
| 4. = | 5.06327132 = | 5 : | 0 : | 6 : | 4.4 = | 4.16634900 |
| 5. = | 6.32908915 = | 6 : | 3 : | 7 : | 35.5 = | 5.20793625 |
| 6. = | 7.59490698 = | 7 : | 7 : | 1 : | 6.6 = | 6.24952350 |
| 7. = | 8.86072481 = | 8 : | 10 : | 2 : | 37.7 = | 7.29111075 |
| 8. = | 10.12654264 = | 10 : | 1 : | 4 : | 8.8 = | 8.33269800 |
| 9. = | 11.39236047 = | 11 : | 4 : | 5 : | 39.9 = | 9.37428525 |

## TABLE

For converting Troy Pounds of Water into their equivalent Wine Pints.

| *Troy Pound* | *Wine Pints* | *Troy Pound* | *Wine Pints.* |
|---|---|---|---|
| 1. = | 0.7900031 | 6. = | 4.7400186 |
| 2. = | 1.5800062 | 7. = | 5.5300217 |
| 3. = | 2.3700093 | 8. = | 6.3200248 |
| 4. = | 3.1600124 | 9. = | 7.1100279 |
| 5. = | 3.9500155 | | |

## TABLE

For converting Troy Pounds into their equivalent Averdupois Pounds.

| *lbs. Troy* | *lbs. Averdups.* | *lbs. Troy* | *lbs. Averdups.* |
|---|---|---|---|
| 1. = | 0.82285714 | 6. = | 4.93714285 |
| 2. = | 1.64571428 | 7. = | 5.76000000 |
| 3. = | 2.46857142 | 8. = | 6.58285714 |
| 4. = | 3.29142857 | 9. = | 7.40571428 |
| 5. = | 4.11428571 | | |

## TABLE

For converting Averdupois Pounds into their equivalent Troy Pounds.

| *lbs. Averd.* | *lbs. Troy* | *lbs. Averd.* | *lbs. Troy* |
|---|---|---|---|
| 1. | = 1.21527$\dot{7}$ | 6. | = 7.29166$\dot{6}$ |
| 2. | = 2.43055$\dot{5}$ | 7. | = 8.50694$\dot{4}$ |
| 3. | = 3.64583$\dot{3}$ | 8. | = 9.72222$\dot{2}$ |
| 4. | = 4.86111$\dot{1}$ | 9. | = 10.93750$\dot{0}$ |
| 5. | = 6.07638$\dot{8}$ | | |

## TABLE

For converting Averdupois Ounces into Decimals of the Averdupois Pound.

| *Oz. Av.* | *lbs. Av.* | *Oz. Av.* | *lbs. Av.* |
|---|---|---|---|
| .25 | = .015625 | 8.00 | = .5000 |
| .50 | = .03125 | 9.00 | = .5625 |
| 1.00 | = .0625 | 10.00 | = .6250 |
| 2.00 | = .1250 | 11.00 | = .6875 |
| 3.00 | = .1875 | 12.00 | = .7500 |
| 4.00 | = .2500 | 13.00 | = .8125 |
| 5.00 | = .3125 | 14.00 | = .8750 |
| 6.00 | = .3750 | 15.00 | = .9375 |
| 7.00 | = .4375 | | |

## TABLE

For converting Decimals of the Averdupois Pound into Averdupois Ounces and Decimals.

| *lbs. Av.* | *oz. Av.* | *lbs. Av.* | *oz. Av.* |
|---|---|---|---|
| .1 | = 1.6 | .01 | = .16 |
| .2 | = 3.2 | .02 | = .32 |
| .3 | = 4.8 | .03 | = .48 |
| .4 | = 6.4 | .04 | = .64 |
| .5 | = 8.0 | .05 | = .80 |
| .6 | = 9.6 | .06 | = .96 |
| .7 | = 11.2 | .07 | = 1.12 |
| .8 | = 12.8 | .08 | = 1.28 |
| .9 | = 14.4 | .09 | = 1.44 |

## TABLE

For converting Ounces, Drams, and Grains Troy into Decimals of the Troy Pound.

| Grain | lbs. Troy | Dram | lbs. Troy | Oz. | lbs. Troy |
|---|---|---|---|---|---|
| 1. = | .000173611 | 1. = | .0104166 | 1. = | .0833 |
| 2. = | .000347222 | 2. = | .0208333 | 2. = | .1666 |
| 3. = | .000520833 | 3. = | .0312500 | 3. = | .2500 |
| 4. = | .000694444 | 4. = | .0416666 | 4. = | .3333 |
| 5. = | .000868055 | 5. = | .0520833 | 5. = | .4166 |
| 6. = | .001041666 | 6. = | .0625000 | 6. = | .5000 |
| 7. = | .001215277 | 7. = | .0729166 | 7. = | .5833 |
| 8. = | .001388888 | | | 8. = | .6666 |
| 9. = | .001562500 | | | 9. = | .7500 |
| | | | | 10. = | .8333 |
| | | | | 11. = | .9166 |

## TABLE

For converting Decimals of the Troy Pound into Troy Ounces, Drams, and Grains.

| lb. | oz. | dr. | gr. | lb. | oz. | dr. | grs. | lbs. | grains |
|---|---|---|---|---|---|---|---|---|---|
| .1 = | 1 | 1 | 36 | .01 = | 0 | 0 | 57.6 | .001 = | 5.76 |
| .2 = | 2 | 3 | 12 | .02 = | 0 | 1 | 55.2 | .002 = | 11.32 |
| .3 = | 3 | 4 | 48 | .03 = | 0 | 2 | 52.8 | .003 = | 17.28 |
| .4 = | 4 | 6 | 24 | .04 = | 0 | 3 | 50.4 | .004 = | 23.04 |
| .5 = | 6 | 0 | 0 | .05 = | 0 | 4 | 48.0 | .005 = | 28.80 |
| .6 = | 7 | 1 | 36 | .06 = | 0 | 5 | 45.6 | .006 = | 34.56 |
| .7 = | 8 | 3 | 12 | .07 = | 0 | 6 | 43.2 | .007 = | 40.32 |
| .8 = | 9 | 4 | 48 | .08 = | 0 | 7 | 40.8 | .008 = | 46.08 |
| .9 = | 10 | 6 | 24 | .09 = | 0 | 8 | 38.4 | .009 = | 51.84 |

## *French Weights and Measures.*

THE numerous and valuable researches of French authors in every branch of chemistry, require a knowledge in the reader of the weights and measures commonly employed by them; which is more particularly necessary, as the denominations common to several measures in both countries express very different quantities both

absolutely and relatively, which sometimes leads to very serious mistakes. Thus the French *pinte* is equal to nearly two English pints: the *gros* or eighth of an ounce contains 72 grains, whereas our *dram*, which is usually reckoned as its equivalent, contains only 60 grains: the French grain is of less absolute weight than the English grain, but the French inch is longer, and hence the same proportion does not hold in the two countries between the measures of weight and capacity.

The standards of weight and measure were totally changed in France about the year 1794, nearly at the time that similar changes were introduced in the divisions of the year, but though the notation of time has now returned to its ancient course, the system of weights and measures appear still to keep their ground, and are actually adopted in all chemical writings. It is highly necessary, however, to give the old, as well as the new system of mensuration, as the most numerous, and as yet the most important, researches, such as those of Lavoisier, Beaumé, Macquer, &c. were made before the present system was adopted.

We possess very accurate standards of comparison between the French weights and measures and our own, the old French having been carefully compared with the English standards by a commission from the Royal Societies of each country in the year 1752; and the modern French *metre* having been compared with equal accuracy with the English inch by Profr. Pictet in 1801.

The old French weights and measures are the following:

The pound *(poids de marc)* contains 9216 grains, and is divided into 16 ounces, the ounce into 8 gros, and the gros into 72 grains: or as follows:

| grains | | | | | |
|---|---|---|---|---|---|
| 24 = | 1 denier | | | | |
| 72 = | 3 = | 1 gros | | | |
| 576 = | 24 = | 8 = | 1 ounce | | |
| 4608 = | 192 = | 64 = | 8 = | 1 marc | |
| 9216 = | 384 = | 128 = | 16 = | 2 = | pound |

| | | | | |
|---|---|---|---|---|
| | | | | *lb. Troy* |
| The French pound is equal to | 7561. | troy grains | = | 1.31268 |
| | | | | *oz. Troy* |
| The French ounce is = | 472.5625 | do | = | .984504 |
| | | | | *dram* |
| The French gros = | 59.0703125 | do | = | .984504 |
| The French grain = | 0.820421 | do | | |
| The Troy pound is equal to | 7021. | French grains | | |
| The Averdupois pound = | 8538. | do | | |

**In the reduction of the French into English measure, the following Table will assist.**

| *French grains* | | *Troy grains* |
|---|---|---|
| 1 | = | 0.820421 |
| 2 | = | 1.640842 |
| 3 | = | 2.461263 |
| 4 | = | 3.281684 |
| 5 | = | 4.102105 |
| 6 | = | 4.922526 |
| 7 | = | 5.742947 |
| 8 | = | 6.563368 |
| 9 | = | 7.383789 |
| 10 | = | 8.20421 |
| 20 | = | 16.40842 |
| 30 | = | 24.61263 |
| 40 | = | 32.81684 |
| 50 | = | 41.02105 |
| 60 | = | 49.22526 |
| 70 | = | 57.42947 |
| 72 | = | 59.070312 |

| *gros* | | *drams* | | *grs.* |
|---|---|---|---|---|
| 1 | = | 0 | : | 59.07 |
| 2 | = | 1 | : | 58.14 |
| 3 | = | 2 | : | 57.21 |
| 4 | = | 3 | : | 56.28 |
| 5 | = | 4 | : | 55.35 |
| 6 | = | 5 | : | 54.42 |
| 7 | = | 6 | : | 53.49 |

| *French oz.* | | *Troy oz.* | | *drams* | | *grs.* |
|---|---|---|---|---|---|---|
| 1 | = | 0 | : | 7 | : | 52.56 |
| 2 | = | 1 | : | 7 | : | 45.12 |
| 3 | = | 2 | : | 7 | : | 37.68 |
| 4 | = | 3 | : | 7 | : | 30.24 |
| 5 | = | 4 | : | 7 | : | 22.80 |
| 6 | = | 5 | : | 7 | : | 15.36 |
| 7 | = | 6 | : | 7 | : | 7.92 |
| 8 | = | 7 | : | 7 | : | 0.48 |
| 9 | = | 8 | : | 6 | : | 53.04 |
| 10 | = | 9 | : | 6 | : | 45.60 |
| 11 | = | 10 | : | 6 | : | 38.16 |
| 12 | = | 11 | : | 6 | : | 30.72 |
| 13 | = | 12 | : | 6 | : | 23.28 |
| 14 | = | 13 | : | 6 | : | 15.84 |
| 15 | = | 14 | : | 6 | : | 8.40 |
| *Pounds* | | | | | | |
| 1 | = | 15 | : | 6 | : | 1 |
| 2 | = | 31 | : | 4 | : | 2 |
| 3 | = | 47 | : | 2 | : | 3 |
| 4 | = | 63 | : | 0 | : | 4 |
| 5 | = | 78 | : | 6 | : | 5 |
| 6 | = | 94 | : | 4 | : | 6 |
| 7 | = | 110 | : | 2 | : | 7 |
| 8 | = | 126 | : | 0 | : | 8 |
| 9 | = | 141 | : | 6 | : | 9 |

The French toise (which corresponds with our fathom) contains 6 feet, the foot is divided into 12 inches, and the inch into 12 lines.

The French half-toise was found by the authentic measurement of the French academy to be equal to 38.355 English inches; and hence

The French foot is equal to 12.785 English inches, or to 1.0654167 *English foot*

The English foot = 11.2632 French inches, or to .9386 *French foot*

The subdivisions of the foot being the same in both countries, their relative proportions are also the same; so that the French inch = 1.0654167 English inches; and the English inch = .9386 French inches.

The old French ell *(Aune)* = 3 *feet* : 7 *inch* : 10.5 *lines* French, = 46.69 *Eng. inches*

| *French feet* | | *English inches* | *Fr. feet or in.* | | *Eng. feet or in.* |
|---|---|---|---|---|---|
| 1 | = | 12.785 | 1 | = | 1.0654+ |
| 2 | = | 25.570 | 2 | = | 2.1308 |
| 3 | = | 38.355 | 3 | = | 3.1962 |
| 4 | = | 51.140 | 4 | = | 4.2616 |
| 5 | = | 63.925 | 5 | = | 5.3270 |
| 6 | = | 76.710 | 6 | = | 6.3925 |
| 7 | = | 89.495 | 7 | = | 7.4579 |
| 8 | = | 102.280 | 8 | = | 8.5233 |
| 9 | = | 115.065 | 9 | = | 9.5887 |
| 10 | = | 127.850 | 10 | = | 10.6541 |
| | | | 11 | = | 11.7195 |
| | | | 12 | = | 12.7850 |

The French square foot or in. = 1.13510 Eng. square foot or in.
The Eng. square foot or inch = .88126 French sq. foot or in.
The French cubic foot or inch = 1.209367 Eng. cubic foot or in.
The Eng. cubic foot or inch = .8268784 French cubic foot or in.

| *French cube foot or inch* | | *Eng. cube foot or inch* | *French cube foot or inch* | | *Eng. cube foot or inch* |
|---|---|---|---|---|---|
| 1 | = | 1.2093+ | 6 | = | 7.2562 |
| 2 | = | 2.4187 | 7 | = | 8.4655 |
| 3 | = | 3.6281 | 8 | = | 9.6749 |
| 4 | = | 4.8374 | 9 | = | 10.8842 |
| 5 | = | 6.0468 | 10 | = | 12.0936 |

When one French cubic inch weighs 1 grain French, or contains 1 gr. of any other substance, 1 English cubic inch of the same weighs or contains .67839 Eng. grain.

For measures of capacity the old French was (as in this country) different for dry measure and for liquids. The common integer for moderate quantities of liquids was the *Pinte,* which is a little more than a quart English wine measure. The *Chopine* is half the *Pinte,* and the *Poison* is a quarter of the *Chopine.* For larger measures, 8 *Pintes* make a *Septier* or *Velte,* and 36 *Veltes* make a *Muid de Vin* Paris measure, for in the provinces both the divisions and their value were different. There appears also to have been, even in Paris, precisely the same kind of variation in the estimation of the *Pinte* as obtains in this country with the wine pint. The French *Pinte* appears to have been legally equivalent to 48 Fr. cubic inches, and then was exactly $\frac{1}{288}$ of the *Muid,* which was 8 cubic feet. But Beaumé, and probably the other apothecaries of Paris (a body of men abounding in excellent and eminent chemists) make the *Pinte* equal to 32 French ounces of water at the freezing point. The respective valuations of the Pinte will therefore be as follows:

| | | lbs. Troy | | En. cub. in. | | Fr. cub. in. | | En. wine pt. |
|---|---|---|---|---|---|---|---|---|
| The pinte of | oz. 32 | = 2.62536 | = | 59.888 | = | 49.52 | = | 2.07404 |
| The pinte of | cub. in. 48 | = | | Eng. cub. in. 58.0489 | = | | | 2.01035 |
| | | | | | | difference | | .06369 = |

to about 7 drams, 40 grs. Troy of water.

The difference of nearly an ounce in a quart is sufficiently great to be often felt in the comparison of experiments. The Pinte of 48 Fr. cubic inches appears for another reason to be the legal standard, since it is thus

given in the comparison of the old with the new French weights. The Pinte is there stated to be equal to .9512 of a *Litre,* which is equal to 2.01038 English wine pints.

For dry measure the French used the *Litron, Boisseau, Minot, Mine,* and *Setier de Bled.* The *Litron* is 36 Fr. cubic inches, equal to 1.4652 Eng. wine pint. The *Minot* of 1728 Fr. cub. inch is equal to 1.0099 Winchester bushel of 2110.4 Eng. cub. inch.

The following are the subdivisions of the old French wine and corn measure.

| Poison | Chopine | Pinte | Septier or velte | Muid de vin |
|---|---|---|---|---|
| 4 = | 1 | | | |
| 8 = | 2 = | 1 | | |
| 64 = | 16 = | 8 = | 1 | |
| 2304 = | 576 = | 288 = | 36 = | 1 |

| Litron | Quart | Boisseau | Minot | Mine | Setier de Bled |
|---|---|---|---|---|---|
| 4 = | 1 | | | | |
| 16 = | 4 = | 1 | | | |
| 48 = | 12 = | 3 = | 1 | | |
| 96 = | 24 = | 6 = | 2 = | 1 | |
| 192 = | 48 = | 12 = | 4 = | 2 = | 1 |

A totally new system of weights and measures has been introduced into the French empire, and is that in which most of the expressions of quantities in chemical experiments are now made. It is therefore necessary in this place to give their corresponding quantities in English measures.

The new French metrical system is founded on a single standard of length which is called the METRE, and is the ten millionth part of the arc of the meridian which extends from the Equator to the Pole, as determined by the actual measurement of a tenth of this arc, between Dunkirk and Barcelona, by several eminent French astronomers. The metre is equal to 36.9413 French inches, which is equal to 39.38272 English inches, the standards of each being at the temperature of melting ice, or 32° Fahr. But

as the standards in this country are always referred to the temperature of 60° or 62° (and the latter is now preferred) the expansion of brass (which is the material of which the standards are made) from 32° to 62° must always be taken into account; for it is obvious that if the English standard is at 62° and the French at 32°, the latter will measure a less quantity of the former than if both were at 32°. The number 39.38272 therefore, which is the equivalent to the French metre when both are at 32°, must be diminished in the proportion in which brass expands 30 degrees, which is estimated by Dr. Young, from Bordas experiments, to make the equivalent to the metre to be 39.371 English inches, the standard of the metre being at 32°, and that of the English inch at 62°.

All the new French measures increase and decrease in decimal proportion, a distinctive prefix being put to the term by which the integer is called. These prefixes are Deca-, Hecto-, Kilo-, and Myria-, (taken from the Greek numerals) to express the *multiplication* of the integer by 10, 100, 1000, and 10000 respectively; and Deci-, Centi-, and Milli-, (from the Latin numerals) to express the *division* of the integer by 10, 100, or 1000. Or according to the following scale, taking the metre as the integer.

| | | *Metres* | | | *Metres* |
|---|---|---|---|---|---|
| 1 Myriametre | = | 10000 | 1 Metre | = | 1. |
| 1 Kilometre | = | 1000 | 1 Decimetre | = | 0.1 |
| 1 Hectometre | = | 100 | 1 Centimetre | = | 0.01 |
| 1 Decametre | = | 10 | 1 Millimetre | = | 0.001 |

The metre is the integer of the measure of length, and from it all the measures of surface, capacity, and weight, are deduced in the following way.

For square dimensions the metre or its parts squared are employed. When used for measuring land the term

*Are* is adopted, which is a decametre squared. A *Hectare,* or 100 *Ares,* are about equivalent to 2 English acres.

For the integer of the measure of capacity, both wet and dry, the decimetre cubed is employed, and is called the *Litre.* It is more than a third larger than the old French Litron, and is equal to $2\frac{1}{8}$ English wine pints.

The cubic metre is also called a *Stere,* but is only used for measuring fire wood, to be substituted for the old French *Corde de Bois.*

For the integer of the measure of weight, the weight of a cubic centimetre of distilled water at 32° has been adopted. This is called a *Gramme,* and is equivalent to abont $15\frac{1}{2}$ English grains.

Of these measures the *Metre, Litre,* and *Gramme,* are almost the only integers that the chemical reader will ever meet with, and certainly their uniformity and exact ratio to each other, and decimal progression, render the comparison of them with our own measures extremely easy.

The following are the correspondences between these and English measures.

The METRE = 39.371 English inches.
The square Metre = 1550.075641 English square inches.
The square Decimetre = 15.50075 English square inches.
*cube feet cube in.*
The Cubic Metre = 61028.028 Eng. cubic inches = 35 : 548.028
The Cubic Decimetre the same as the Litre.
*English cubic inches*
The LITRE, equal to the bulk of Kilogramme of water = 61.028
*Troy grains*
The GRAMME, or weight of a cubic centimetre of water = 15.44402

## The following Tables will assist the Reader.

| *Metre* | | *Eng. feet.* | | *Inches* |
|---|---|---|---|---|
| 1 | = | 3 | : | 3.371 |
| 2 | = | 6 | : | 6.742 |
| 3 | = | 9 | : | 10.113 |
| 4 | = | 13 | : | 1.484 |
| 5 | = | 16 | : | 4.855 |
| 6 | = | 19 | : | 8.226 |
| 7 | = | 22 | : | 11.597 |
| 8 | = | 26 | : | 2.968 |
| 9 | = | 29 | : | 6.339 |

| *Decimetre* | | *Eng. Inches* |
|---|---|---|
| 1 | = | 3.9371 |
| 2 | = | 7.8742 |
| 3 | = | 11.8113 |
| 4 | = | 15.7484 |
| 5 | = | 19.6855 |
| 6 | = | 23.6226 |
| 7 | = | 27.5597 |
| 8 | = | 31.4968 |
| 9 | = | 35.4339 |

| *Litre* | | *Eng. cub. inch* | | *Ale pints* | | *Wine pints* | | *Oz. Troy of water* |
|---|---|---|---|---|---|---|---|---|
| 1 | = | 61.028 | = | 1.7313 | = | 2.11353 | = | 32.104 |
| 2 | = | 122.056 | = | 3.4626 | = | 4.22706 | = | 64.208 |
| 3 | = | 183.084 | = | 5.1939 | = | 6.34059 | = | 96.312 |
| 4 | = | 244.112 | = | 6.9252 | = | 8.45412 | = | 128.416 |
| 5 | = | 305.140 | = | 8.6565 | = | 10.56765 | = | 160.520 |
| 6 | = | 366.168 | = | 10.3878 | = | 12.68118 | = | 192.624 |
| 7 | = | 427.196 | = | 12.1191 | = | 14.79471 | = | 224.728 |
| 8 | = | 488.224 | = | 13.8504 | = | 16.90824 | = | 256.832 |
| 9 | = | 549.252 | = | 15.5817 | = | 19.02177 | = | 288.936 |

| *Gramme.* | | *Troy grs.* |
|---|---|---|
| 1 | = | 15.444 |
| 2 | = | 30.888 |
| 3 | = | 46.332 |
| 4 | = | 61.776 |
| 5 | = | 77.220 |
| 6 | = | 92.664 |
| 7 | = | 108 108 |
| 8 | = | 123.552 |
| 9 | = | 138.996 |

| *Deca-gramme* | | *Troy dram* | | *grs.* |
|---|---|---|---|---|
| 1 | = | 2 | : | 34.44 |
| 2 | = | 5 | : | 8.88 |
| 3 | = | 7 | : | 43.32 |
| 4 | = | 10 | : | 17.76 |
| 5 | = | 12 | : | 52.20 |
| 6 | = | 15 | : | 26 64 |
| 7 | = | 18 | : | 1.08 |
| 8 | = | 20 | : | 35.52 |
| 9 | = | 23 | : | 9.96 |

| *Hecto-gramme* | | *Troy oz.* | | *Averd. oz.* |
|---|---|---|---|---|
| 1 | = | 3.2175 | = | 3.5279 |
| 2 | = | 6.4350 | = | 7.0558 |
| 3 | = | 9.6525 | = | 10.5837 |
| 4 | = | 12.8700 | = | 14.1116 |
| 5 | = | 16.0875 | = | 17.6395 |
| 6 | = | 19.3050 | = | 21.1674 |
| 7 | = | 22.5295 | = | 24.6953 |
| 8 | = | 25.7400 | = | 28.2232 |
| 9 | = | 28.9575 | = | 31.7511 |

The decimal progression of all the French weights and measures renders it only necessary to change the decimal point in order to convert one into the equivalent of any other, of the same species and numerically the same, but of a different denomination. Thus as 9 litres are equal to 15.5817 ale pints, 9 hectolitres will be equal to 1558.17 ale pints; and so of the rest.

## *German Weights and Measures.*

A Vast variety of weights and measures are in local use in Germany, as slight differences exist between the *mark, ell,* &c. of almost every state. There appears, however, from the accurate account given by Gren (in his System. Handbuch der Chemie, Vol. I.) to be two kinds of weight, to which all those employed in Germany may be referred, and which are sufficient for our present purpose.

The ancient and most authentic standard of weight is the

*Cologne mark,* or *Mark of Charlemagne,* with its divisions. The mark is the highest integer used in this standard which was intended for gold and silver, but it is also considered as half the Cologne pound. The *mark* contains 8 ounces, the *ounce* 2 loths, the *loth* 4 quentchens or drams, and the *quentchen* 1 pfenning, pennyweight, or denier. Besides this, the *pfenning* is subdivided into 256 *Recht-pfenning theil,* or standard parts, which last division, however, is only hypothetical, but is extremely useful for comparison; for as the pfenning is itself the 256th part of the mark, the latter contains 65536 standard parts, which is a sufficiently minute division for all actual calculations. The Cologne Mark therefore is thus divided:

| *Standard parts* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 256 | = | 1 Pfenning | | | | | | | | |
| 1024 | = | 4 | = | 1 Quentchen | | | | | | |
| 4096 | = | 16 | = | 4 | = | 1 Loth | | | | |
| 8192 | = | 32 | = | 8 | = | 2 | = | 1 Ounce | | |
| 65536 | = | 256 | = | 64 | = | 16 | = | 8 | = | 1 Mark |

Also two marks make a pound. The Pfenning is further subdivided either into 2 *Heller*, or into 17 *Eschen*, or into 9 *As*.

The *Grain* weight therefore does not enter into this division of the Cologne Mark, but in the division for weighing gold and silver it is used, as will be mentioned.

The other set of weights used commonly in Germany is the *Nuremburg Medicinal Weight*, the integer or pound of which is divided precisely the same as the apothecaries' division of the English pound Troy; that is to say, the pound into 12 ounces, the ounce into 8 drams, the dram into 3 scruples, and the scruple into 20 grains. Neither the pound nor ounce nor dram of the Nuremburg weight are the same as the pound, ounce, and quentchen of the Cologne weight, the Nuremburg pound being = 100423.5 standard parts — and the ounce = 8368.625 St. Pts. For commerce and common use the Nuremburg pound is increased to 16 ounces = 133898 St. Pts.

The Nuremburg medicinal pound of 12 ounces appears to be the standard for apothecaries' weight all over Germany, and therefore is probably that which is more commonly used by chemists. Hence, when we meet with the term pound, ounce, dram, and grains, in German chemical authors, we may generally conclude that it is the Nuremburg medicinal weight, unless otherwise specified.

But the Cologne Mark weight is employed universally for assaying gold and silver, and therefore is also of very frequent occurrence.

The English Troy pound is given by Gren as equal to 104688 St. Pts. of the Cologne Mark, whence the Nuremburg pound, ounce, dram, scruple or grain = .959266 English Troy pound, ounce, dram, &c. respectively: or by the following Table.

| *Nuremburg* | | *Eng. Troy* | *Nuremburg* | | *Eng. Troy* |
|---|---|---|---|---|---|
| 1 | = | 0.95926 | 6 | = | 5.75560 |
| 2 | = | 1.91853 | 7 | = | 6.71486 |
| 3 | = | 2.83780 | 8 | = | 7.67418 |
| 4 | = | 3.83706 | 9 | = | 8.63339 |
| 5 | = | 4.79633 | | | |

The Cologne ounce is = 8192 standard pts. and the Troy ounce is = 8724 st. pts. whence the Cologne ounce, and eighth of an ounce (or quentchen) is = .939018 Troy ounce or dram respectively: and the Cologne mark is = 7.512144 Troy ounces: or by the following table:

| *Cologne oz. or Quentchen.* | | *Troy oz. or dr.* | *Cologne oz or Quentchen.* | | *Troy oz. or dr.* |
|---|---|---|---|---|---|
| 1 | = | .939 | 6 | = | 5.634 |
| 2 | = | 1.878 | 7 | = | 6.573 |
| 3 | = | 2.817 | 8 | = | 7.512 |
| 4 | = | 3.756 | 9 | = | 8.451 |
| 5 | = | 4.695 | | | |

When gold and silver are weighed in Germany by the Cologne mark, it has a totally different subdivision from the common ounce, quentchen, and pfenning.

For gold, the mark is divided into 24 carats, and the carats into 12 grains. The *Carat* therefore, where it is a real weight, is equal to 150.242 Troy grains, and the *Grain*, or 288th part of the mark, is equal to 12.52 Troy grains.

For silver, the mark is divided, as usual, into 16 *Loths*, or half ounces, but the loth into 18 *Grains*. The grain is in this case also the 288th part of the mark. This circumstance of employing the term *grain* occasionally for a subdivision of the mark, and giving to it a value upwards of 13 times the Nuremburg grain, should be carefully noted, as many errors may arise from it, particularly to the English reader.

The method of conducting the assay of gold and silver has been described under the article of Assay, and it is there mentioned (p. 117)* that the small piece of gold cut off the ingot to be assayed is called an *Assay mark*, and (like the real mark of gold) is divided into 24 carats, and each carat into 12 grains, by small sets of weights used for this purpose. The actual quantity of gold used for this purpose is half a pfenning, or $\frac{1}{512}$ of a

* Of Aikin's Dictionary.

real mark = 128 standard parts, or about 7 grains Troy. The assay grain is further divided into halves and quarters. The *Assay mark for Silver* is divided as the real mark for this metal, namely, into 16 loths, and each loth into 18 grains, and the grain into halves and quarters; and the real weight of the silver assay mark is twice that of gold, or one pfenning.

The German assayers and mineralogists have also the *Docimastic Centner,* which has generally the actual weight of one quentchen (equal to 56.34 grains Troy) but is subdivided into 100 docimastic pounds, each of which therefore is equivalent to about $\frac{1}{2}$ grain Troy.

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The most common measure of length in Germany is the *Rhinland foot,* to which standard the foot, ell, &c. of the different states is usually compared.

With regard to the length of this measure in English inches, the *Pied du Rhin* is said in Peuchet's Dict. de Commerce, to be = 11 inch. : 7 lines, of the old French *Pied de Roi,* which is = 12.341 English inches. Hence we have the following numbers, viz. 1 Rhinland foot = 12.341 English inches, and therefore 1 Rhinland inch = 1.02842 English inches, and 1 cubic inch Rhinland = 1.08769 English cubic inches, = 274.648 Troy grains of distilled water = 286.31 Nuremb. grains.

On the other hand, Klaproth, in his analysis of the Carlsbad water, and in the other parts of his works, employs the cubic inch, which, he says, holds 290 of the true Nuremburg grains of distilled water, and which appears to be as common a standard of length among the German chemists as the Nuremburg is of weight. Now according to Gren, 290 Nuremb. grains, = 278.187 Troy grains, = 1.10169 English cubic inch. of water, and the cube root of 1.101700+ (which hardly differs from

1.101693) is = 1.032812. So that the inch used by Klaproth is probably the Rhinland inch, which by this estimation is = 1.032812 English inches, and by the is = 1.02842 English inches, the difference being only about .0044.

We may therefore without danger of material error, consider the inch used by most of the German chemists (unless otherwise specified) as that which, when cubed, contains 290 Nuremburg grains of water, and as having the following proportions with the English.

| *Germ. feet* | *or in.* | *Eng. feet or in.* | *Germ. cub. in.* | | *Eng. cub. in.* |
|---|---|---|---|---|---|
| 1 | = | 1.0328 | 1 | = | 1.1017 |
| 2 | = | 2.0656 | 2 | = | 2.2034 |
| 3 | = | 3.0984 | 3 | = | 3.3051 |
| 4 | = | 4.1312 | 4 | = | 4.4068 |
| 5 | = | 5.1640 | 5 | = | 5.5085 |
| 6 | = | 6.1969 | 6 | = | 6.6102 |
| 7 | = | 7.2297 | 7 | = | 7.7119 |
| 8 | = | 8.2625 | 8 | = | 8.8136 |
| 9 | = | 9.2953 | 9 | = | 9.9153 |

When 1 German cubic inch weighs or contains 1 Nuremburg grain; 1 cubic inch English weighs or contains .8707 Troy grain.

## No. 3.

*Report made by the Physical and Mathematical Class of the Institute in Answer to the Question, whether those Manufactories, from which a disagreeable Smell arises, may prove injurious to Health. Read in the Sitting of January, 1805, by Messrs.* Guyton-Morveau and Chaptal.*

THE minister of the home department has consulted the class on a question, the solution of which is of essential import to our manufacturers.

* Phil. Jour. Vol. 12. p. 122. from An. de Chim. Vol. 54.

The object is to determine, whether the vicinity of certain manufactories can be injurious to health.

The solution of this problem must appear of the more consequence, as, from the confidence which the decisions of the Institute naturally merit, it may hereafter form the basis of decisions in a court of justice, when sentence is to be pronounced between the fate of a manufactory and the health of our fellow-citizens.

The solution is so much the more important, it is become so much the more necessary, as the fate of the most useful establishments, I will say more, the existence of many arts, has depended hitherto on simple regulations of police; and that some, driven to a distance from materials, from workmen, or from consumers, by prejudice, ignorance, or jealousy, continue to maintain a disadvantageous struggle against innumerable obstacles, by which their growth is opposed.

Thus we have seen manufactories of acids, of sal ammoniac, of Prussian blue, of beer, and of leather, successively banished from cities; and we daily see appeals to authority against these establishments made by troublesome neighbours or jealous rivals.

As long as the fate of these manufactories is insecure, as long as an arbitrary legislation possesses a right to interrupt, suspend, or fetter the hands of a manufacture; in a word, as long as a simple magistrate of police has at his nod the fortune or ruin of a manufacturer, how can we conceive, that he will be so imprudent as to engage in undertakings of such a nature? How could it be expected, that manufacturing industry should establish itself on such a frail basis? This state of uncertainty, this continual contest between the manufacturer and his neighbours, this perpetual doubt respecting the fate of an establishment, paralize and confine the efforts

of the manufacturer, and gradually extinguish both his courage and his powers.

It is an object of primary necessity therefore to the prosperity of the arts, that lines should be drawn, so as no longer to leave any thing at the arbitrary will of the magistrate; to point out to the manufacturer the circle in which he may exert his industry with freedom and security, and to assure the neighbouring proprietor that he has nothing to fear for his health, or for the produce of his fields.

To arrive at the solution of this important problem, it appeared to us indispensable, that we should take a view of each of the arts, against which the most clamour has been raised.

With this view we shall divide them into two classes. The first will comprise all those, the processes of which allow aeriform emanations to escape from them into the atmosphere, either in consequence of putrefaction or fermentation, which may be deemed nuisances from their smell, or dangerous from their effects.

The second class will include all those, in which the artist, operating by the aid of fire, developes and evolves in air or vapour various principles, which are more or less disagreeable to respire, and reputed more or less injurious to health.

In the first class we may advert to the steeping of flax and hemp, the making of catgut, slaughter-houses, starch-manufactories, tanneries, breweries, &c.

In the second, the distillation of acids, of spirits, and of animal substances; gilding on metals, preparations of lead, copper, and mercury, &c.

The arts of the first class, considered in relation to the health of the public, merit particular attention, because the emanations that proceed from fermentation or putrefaction are really injurious to health in some cases.

and under certain circumstances: the steeping of flax and hemp, for instance, which is performed in ponds or still waters, infects the air and kills fishes; and the diseases to which it gives rise are all known and described: Accordingly wise regulations have almost every where enjoined, that this operation should be carried on without the precincts of towns, at a certain distance from every dwelling, and in waters, the fish of which constitute no resource for the public. These regulations unquestionably ought to be continued; but as the execution of them is attended with some inconvenience, it is to be wished, that the process of Mr. Brale, the superiority of which has been confirmed by Messrs. Mongez, Berthollet, Tessier, and Molard, should soon become known and adopted.

Other operations on vegetables, or certain products of vegetation, to obtain fermented liquors, as in breweries; to extract colours, as in the manufactures of litmus, archil, and indigo; or to divest them of some of their principles, as in manufactories of starch, paper, &c. do not appear to us of such a nature as to be capable of exciting any disquietude in the mind of the magistrate. At all events, the emanations arising from these substances in a state of fermentation can prove dangerous only near the vessels and apparatus in which they are confined, ceasing to be so the moment they are mingled with the open air; so that a little prudence only is required, to avoid all danger from them. Besides, the danger affects only the manufacturers themselves, and by no means the inhabitants of the neighbouring houses, so that a regulation enjoining these manufactories to be removed out of towns, and to a distance from any dwelling-house, would be an act of authority both unjust, vexatious, and injurious to the progress of manufactures, and in no respect a remedy for the evils attending the operation.

Some preparations extracted from animal substances require the putrefaction of these substances, as in the fabrication of catgut: but it is more frequently the case, that animal substances employed in manufactures are liable to putrefaction from being kept too long, or exposed to too great warmth, as we particularly find in dyeing cotton red, a process in which a large quantity of blood is employed. The miasmata exhaled by these putrid matters spread far round, and form a very disagreeable atmosphere for all the neighbourhood to breathe: it is the part of a good government, therefore, to cause these substances to be renewed so as to prevent putrefaction, and the manufactory to be kept so far clean, that no refuse of the animal substances employed shall be left to rot in them.

In this last point of view slaughter-houses exhibit some inconveniencies; but they are not of sufficient importance to require them to be placed without the precincts of towns, and assembled together in one spot, as speculative men are daily proposing to government. A little attention on the part of the magistrate, to prevent butchers from throwing out the blood and refuse of the beasts they kill, would be sufficient to remedy completely every thing disgusting or unhealthy arising from slaughter-houses.

The fabrication of *poudrette* (night-soil dried) begins to be established in all the large towns of France, and the operation by which excrementitious substances are reduced to this state, necessarily occasions a very disagreeable smell for a long time. Establishments of this kind therefore ought to be confined to airy places, remote from any habitation: not that we consider the aeriform exhalations from them as injurious to health; but no one can deny, that they are incommoding, noisome, disagreeable, and difficult to breathe, on all which accounts they

ought to be removed to a distance from the dwellings of men.

There is a very important observation to be made on the spontaneous decomposition of animal substances, which is, that the emanations from them appear to be so much the less dangerous, as the substances which undergo putrefaction are less humid: in the latter case, a considerable quantity of carbonate of ammonia is evolved, which imparts its predominant character to the other matters volatilised, and corrects the bad effects of such as are deleterious. Thus the decomposition of stercoraceous matters in the open air, and in places the situation and declivity of which allow the fluids to drain off, and that of the refuse of the cocoons of the silk-worm evolve a vast quantity of carbonate of ammonia, which corrects the virus of some other emanations; while the very same substances, decomposed in water or drenched with this fluid, exhale sweetish and nauseous miasmata, the respiration of which is very dangerous.

The numerous arts in which the manufacturer produces and diffuses in the air, in consequence of his processes and by the help of fire, vapours more or less disagreeable to breathe, constitute the second class of those we have to examine.

These, more interesting than the former, and much more intimately connected with the prosperity of our national industry, are still oftener the subject of complaints brought before the magistrate for decision, and on this account have appeared to us to require more particular attention.

We will begin our examination with the manufacture of acids.

The acids that may excite complaints of the neighbours against their preparation are the sulphuric, nitric, muriatic, and acetous.

The sulphuric acid is obtained by the combustion of a mixture of sulphur and nitre. It is very difficult in this process to prevent a more or less observable smell of sulphurous acid from being diffused around the apparatus, in which the combustion is performed: but in manufactories skilfully conducted this smell is scarcely perceptible within the building itself, is not dangerous to the workmen who respire it daily, and can give no reasonable foundation for complaint to the neighbours. When the art of making sulphuric acid was introduced into France, the public opinion was strongly expressed against the first establishments for the purpose: the smell of the match with which we kindle our fires contributed not a little to exaggerate the effect that must be produced by the rapid combustion of several hundred weight of brimstone: but men's fears on this head are now so much allayed, that we see several of these manufactories prosper in peace in the midst of our cities.

The distillation of aqua fortis and spirit of salt, in other words, of the nitric and muriatic acids, are not more dangerous than that of sulphuric acid. The whole of the process is performed in an apparatus of glass or earthen-ware, and it is unquestionably the great interest of the manufacturer to diminish the volatilization or loss of the acid as much as possible. Yet, let him pay whatever attention he will to this, the air breathed in the manufactory is always impregnated with the smell peculiar to each of these acids; but you may respire there freely and safely, the men who work in it daily are not at all incommoded by it, and the neighbours would be very much in the wrong to complain.

Since the manufactories of white lead, of verdigris, and of sugar of lead, have increased in France, the demand for vinegar has been enlarged.

When this acid is distilled, to fit it for some of the

purposes for which it is used, it diffuses to a distance a very strong smell of vinegar, in which there is no danger: but when a solution of lead in this acid is evaporated, the vapours assume a sweetish character, and produce in those who respire them constantly, all the effects peculiar to the emanations of lead itself. Happily these effects are confined to the people who work in the manufactory, and are unfelt by those who dwell in the vicinity.

The preparations of mercury and of lead, those of copper, antimony, and arsenic, and the processes of gilding on metals, are none of them without some danger to the persons who reside in those manufactories, and are concerned in the operations; but their effects are bounded by the walls within which they are carried on, and are dangerous only to the persons concerned in the manufactories. It is an object well worthy the attention of chemists, to investigate the means of preventing these injurious effects, and indeed many of the inconveniencies have already been prevented by the help of chimneys, which convey the vapours into the air out of the reach of respiration; and at the present the whole attention of administration ought to be confined to directing science toward the means of improvement of which these processes are susceptible with regard to health.

The fabrication of Prussian blue, and the extraction of carbonate of ammonia by the distillation of animal substances in the new manufactories of sal ammoniac, produce a large quantity of fetid vapours or exhalations. These exhalations, it is true, are not injurious to health; but as it is not sufficient to constitute a good neighbour, not to be a dangerous one merely, but not even to be a disagreeable one, they who undertake such manufactures, when they have to seek a situation for them, should prefer one remote from any dwelling-house. But when

such a manufactory is already established, we would be far from advising the magistrate to order its removal: it would be sufficient in such cases, to oblige the manufacturer to build very high chimneys, that the disagreeable vapours produced in these operations may be dissipated in the air. This is particularly practicable for the fabrication of Prussian blue, and by adopting it one of our number has continued to retain in the midst of Paris one of the most important manufactories of this kind we have, against which the neighbours had already leagued.

In the report we lay before the class we have thought it our duty to attend only to the principal manufactories, against which violent clamours have been raised at divers times and places. It is easy to see, from what has been said, that there are but few the vicinity of which is injurious to health.

Hence we cannot too strongly exhort those magistrates who have the health and safety of the public committed to their charge, to disregard the unfounded complaints, which, too frequently brought against different establishments, daily threaten the prosperity of the honest manufacturer, check the progress of industry, and endanger the fate of art itself.

The magistrate ought to be on his guard against the proceedings of a restless or jealous neighbour; he should carefully distinguish what is only disagreeable or inconvenient from what is dangerous or injurious; he should recollect that the use of pit-coal was long proscribed, under the frivolous pretence that it was injurious to health; in short, he should be fully aware of this truth, that, by listening to complaints of this nature, not only would the establishment of several useful arts in France be prevented, but we should insensibly drive out of our cities the farriers, carpenters, joiners, braziers, coopers, founders, weavers, and all whose occupation is more or less

disagreeable to their neighbours. For certainly the employments just named are more unpleasant to live near than the manufactories mentioned above, and the only advantage they enjoy is that of ancient practice. This right of toleration has been established by time and necessity; let us not doubt therefore, but our manufactures, when grown older and better known, will peaceably enjoy the same advantage in society; in the mean time we are of opinion, that the class ought to avail itself of this circumstance, to put them in a particular manner under the protection of government, and declare publicly, that the manufactures of acids, sal ammoniac, Prussian blue, sugar of lead, white lead, starch, beer, and leather, as well as slaughter-houses, are not injurious to the health of the vicinity, when they are properly conducted.

We cannot say as much for the steeping of hemp, making catgut, laystalls, and in general establishments where a large quantity of animal or vegetable matter is subjected to humid putrefaction. In all these cases, beside the disagreeable smell they exhale, miasmata, more or less deleterious, are evolved.

We must add, that, though the manufactories of which we have already spoken, and which we have considered as not injurious to the health of the neighbourhood, ought not to be removed, yet administration should be requested to watch over them strictly, and consult with well-informed persons for prescribing to the conductors the most proper measures for preventing their smoke and smell from being diffused in the vicinity. This end may be attained by improving the processes of the manufactures, raising the outer walls, so that the vapours may not be diffused among the neighbours; improving the management of the fires, which may be done to such a point, that all the smoke shall be burnt in the fire-place, or deposited in the tunnels of long chimneys; and main-

taining the utmost cleanliness in the manufactories, so that nothing shall be left to putrify in them, and all the refuse capable of fermentation be lost in deep wells, and prevented from any way incommoding the neighbours.

We shall observe too, that when new manufactories of Prussian blue, sal ammoniac, leather, starch, or any other article by which vapours very inconvenient to the neighbours, or danger of fire or explosions are to be established, it would be wise, just, and prudent, to lay down as a principle, that they are not to be admitted into cities, or near dwellings, without special authority; and that, if persons neglect to comply with this indispensable condition, their manufactories may be ordered to be removed without any indemnification.

It follows from our report, 1st, that catgut manufactories, laystalls, steeping of hemp, and every establishment in which animal or vegetable matters are heaped together to putrify in large quantities, are injurious to health, and ought to be remote from towns and every dwelling house: 2dly, that manufactories where disagreeable smells are occasioned through the action of fire, as in the making of acids, Prussian blue, and sal ammoniac, are dangerous to the neighbours only from want of due precautions, and that the care of government should extend only to an active and enlightened superintendance, having for its objects the improvement of their processes and of the management of the fire, and the maintenance of cleanliness: 3dly, that it would be worthy a good and wise government, to make regulations prohibiting the future establishment of any manufacture, the vicinity of which is attended with any essential inconvenience or danger, in towns or near dwelling-houses, without special authority previously obtained. In this class may be comprised the manufactories of poudrette, leather, and starch; foundries, melting houses for tal-

Manufacture of Gun flints.

low, slaughter-houses, rag warehouses, manufactories of Prussian blue, varnish, glue, and sal ammoniac, potteries, &c.

Such are the conclusions which we have the honour to lay before the class, and addressed to government, with invitation to make it the base of its decisions.

## No. 4.

## *A Memoir on the Art of making Gun-Flints.*

*By* CITIZEN DOLOMIEU.*

With an Engraving.

THE art of making gun-flints, which has been long practised in a small territory situated between the two neighbouring departments of Loir-Cher and L'Indre, is directed to an object, of which the whole value, commercially considered, is of little magnitude; but which is of the first necessity in the use of fire-arms of every description. The author of the present Memoir was desirous of acquiring some information respecting it, but found that it was to no purpose that he extended his researches to a variety of works on mineralogy and different subjects of the arts and trade. The Encyclopédie is silent on this process; excepting in the repetition of a ridiculous prejudice concerning the re-production of flints in places whence they were excavated. From the precision with which the figure is given to these stones, it

* Nich. Phil. Jour. vol. 1. p. 88. from Mem. de l'Institute Nationale, 3. 348.

NOTE. Whether the true gun-flint has been found in America I do not at present recollect; there can however be little doubt that it exists among us; it is of too great national importance to depend for our supplies from foreign sources, of an article of such prime necessity, and it may be hoped that the present communication will lead to a due investigation of the subject. Dr. Seybert states in the Philadelphia Medical Museum, Vol. 5. p. 157. that "large masses of common flint are found near Easton, Northampton county, and near Reading, Berks county, Pennsylvania," and appropriates to it the name by which the author of the present essay describes the true gun-flint. ED.

has even been suspected that they could hardly be afforded at the low price they bear, if in its first state the material were not even soft. But the art is extremely simple in its process; it requires a very small number of instruments, a short apprenticeship, and a very moderate degree of skill to form, by mere fracture, figures so accurate, faces so smooth, outlines so direct, and angles so neat, that the stone seems as if cut on the wheel of the lapidary. Five or six small blows of the hammer, during one minute of time, are sufficient to produce the same perfection of figure as would require more than an hour's labour, if the sections were to be made by grinding against harder substances, or friction with emery. Less than a farthing will pay for a gun-flint from the hand of the workman, but fifty times that sum would be insufficient for its purchase if it were fashioned by any other process.

The author regularly proceeds to examine first the material best adapted to the use in question, the instruments employed, and the manipulation by which the stones are fashioned.

With regard to the material, every kind of stone, capable of producing strong sparks when struck against steel, may be used as a gun-flint, if it can but be fashioned by simple and cheap means. But even in this case there are some motives of preference; such, for example, as that the scintillation should be produced with the least possible blow, and with no considerable wear or abrasion of the steel. These reasons of predilection are in favour of the siliceous stones, when compared with those which are called quartzose. But the silex or flint, properly so called, possesses not only this kind of superiority, but another property, that it is more particularly susceptible of being broken into fragments or plates, which require but very little labour to give them the requisite form and dimensions.

Among the silex it is therefore that the fabricators of gun-flints have found the material truly proper for the exercise of the art. And among the numerous varieties of this species of stone, there is only one which can be advantageously fashioned by the hammer alone. The agates and chalcedonies, which are also applied to this use, are brought to the requisite form by the mill of the lapidary. The makers of gun-flints in France denominate the stone of which they make use *caillou*, and they themselves are called *caillouteurs*. The word *caillou* is used by them to denote the best and most serviceable kind of flint; whereas, in the other parts of France, it denotes a pebble; that is to say, a rounded stone, whatever may be its nature.

The flint of the workmen in gun-flints belongs to that species of silex which naturalists have denominated silex gregarius, silex ignarius, or the feuerstein of the Germans, &c. But every coarse flint is not proper for this use. In fact, the best stone is far from being plentiful in nature. Many countries are entirely deprived of them; and the author thinks that it may probably be affirmed, that France almost alone possesses that variety of silex which can be easily broken into gun-flints, since he cannot suppose that the art of making them could remain a mystery to other nations who do not practice it, though they make great use of the flints: the art itself being so simple, that they must have speedily acquired it, if they have possessed the material.

In his description of the variety of silex here alluded to, he gives it the name of silex pyromachus, to express its use, which he prefers to the term silex sclopetarius, as being more musical.

The external characters are:

The silex pyromachus, when dug up, is always covered with a white external crust, one or two lines or more

in thickness, of an earthy, chalky appearance, and loose texture, much softer and less heavy than the silex it envelopes. The external form of the masses of good stones of this description has a somewhat convex surface, approaching to the globular figure. Those of irregular forms are full of imperfections. The best stones are not very large. They seldom exceed the weight of twenty pounds, and they ought not to be of less weight than one or two pounds. Their aspect, when broken, is greasy, shining a little, and the grain is so fine, that it is imperceptible. The colour of these good stones may vary from the yellow colour of honey to a blackish brown. In this respect it is to be noted that the value of a stone does not depend on its colour, but on the uniformity of the tint, which becomes less intense when the stone is reduced into thin splinters. The flints of the two departments first mentioned are yellowish. Those of the chalk hills on the banks of the Seine are blackish brown. Both the one and the other, when pulverised, are perfectly white. The silex pyromachus ought to possess an uniform semi-transparence, of a greasy aspect, to such a degree, as to admit letters to be distinguished through a piece of the stone of one-fiftieth of an inch thick, laid close upon the paper. Its fracture must be smooth and equal throughout, and very slightly conchoidal; that is to say, convex or concave. This kind of fracture is one of the most essential properties upon which the faculty of being divided into gun-flints depends.

The workmen select the stones proper for their use by their external character. They compare that part of the masses of silex, which is uniformly semi-transparent and coloured, to the inner skin of bacon, which they call *couenne*. They say that one flint has more or less *couenne*, or is more or less fat than another. They assert

that the upper part of a flint is always of a better quality than the lower. Flints are considered as imperfect or intractable when naturally deprived of any of the external characters before indicated, or when injured by long exposure to the air. Most of the masses are subject to have whitish opaque spots and a kind of knots where the material is harder than in the other part of the stone. When these accidents are too abundant, the stone is rejected as useless.

The physical characters are as follow :—Specific gravity of the white silex pyromachus from the banks of the Cher proved to be 26041 ; that of the blackish kind from the chalk isles of Laroche Guion was 25954. In this respect it does not differ essentially from the other varieties of silex, of which the specific gravities are usually between 26100 and 25900. Hardness a little superior to that of jasper, but inferior to that of agate and chalcedony. It is nearly the same as that of the other common flints. Brittleness. It is more brittle than most other siliceous stones. The light coloured is more so than the darker ; these last being rather more scintillant, and wear away the hammer more quickly. When two pieces of the silex pyromachus are strongly rubbed together, they emit the peculiar well known smell of siliceous stones, but in this variety it is more strong than in any other.

Chemical characters. Action of the air.

The silex pyromachus, deprived of its natural coating, and exposed for a long time to the changes of the atmosphere, acquires a second white friable coating, consisting of the silex reduced to powder ; and even its internal part loses its greasy appearance and semi-transparency, so as to become whitish. In this case the specific gravity, which was 25954, becomes 25754, consequently it has lost 200 parts of the weight it possessed at first.

The silex pyromachus is sometimes too moist when taken out of the quarry. It requires to be dried; but if by too long exposure to the air or the wind it loses a certain portion of humidity which is often very perceptible when it is recent, it can then no longer be broken into gun-flints, as its fracture is less easy. The workmen carefully reject all those which have lost this favourable degree of moisture. Perhaps they might be restored by keeping them in a damp place, or covering them with earth, and by these means at least they might succeed in preserving those intended to be worked up in winter.

When the fragments are thrown upon a red hot plate of iron, it flies and cracks, and becomes opaque. When projected in powder upon nitre in fusion, it gives a few sparks with slight inflammation and detonation.

When calcined in a test, it loses one 250th part of its weight, increases in bulk, becomes extremely white, and so brittle as to be almost friable. In this state it resembles the finest porcelain biscuit.

When distilled in a retort by strong heat, it affords a little carbonic acid gas, and a quantity of water amounting to 200 parts of the weight before indicated as its specific gravity; but gives no sign of the combustible matter which in the preceding experiment caused the nitre to detonate.

This water, which appears essential to all the flints, and may be called their radical water, is the cause of their transparency. Exposure to air by drying them, renders them opaque; so that they may be considered as imperfect hydrophanes; for they do not again absorb, but with difficulty the water necessary to their transparence. This water also contributes to the connexion of their integrant particles, whence their fracture becomes more equal, and is harsh when they have lost it. These flints when recently dug up even afford an aqueous vapour

when struck, and the face of the fracture is humid, and as it were moist.

Chemical analysis.

Citizen Vanquelin examined 100 parts of silex pyromachus of a brownish colour, and uniformly semi-transparent from the hills of La Roche Guion. He mixed the mass with 400 grains of very pure potash, which by fusion in a silver crucible afforded a compound, which after cooling was diffused in water, and then super-saturated with muriatic acid. The very clear solution was evaporated to dryness, re-dissolved in water, and the silex thus saturated, and left upon the filter after being well washed, dried and ignited, weighed 97 grains. Ammonia was afterwards added to the clear liquid, where it produced a slight yellowish white precipitate, which after being well washed and dried weighed one grain, and was found to be a mixture of alumine and oxide of iron. The fluid separated from this small portion of iron and alumine, gave no other precipitate on the addition of carbonate of potash, and the waters used in the washing left no residue when they were evaporated to dryness. The result therefore was silex = 97 grains, alumine and oxide of iron = 1, loss = 2, The author considers it to be a very remarkable fact, that the silex pyromachus should contain only silex and water, the alumine and iron being too small in quantity to be considered as essential to its composition, or to influence its habitudes. Quartz also, from the analyses which have been made, appears to contain only silex ; yet the more he examines the two substances, the more he finds reason to suppose them essentially different from each other ; since the one refuses to assume the crystalline form, and the other assumes it and becomes clear, even in contact with the flint itself. The one appears to be incapable of admitting water into its composition, while the other constantly contains it until it

begins to be decomposed. He offers a query, whether the difference may not consist in the small portion of combustible or fatty matter, which caused the detonation with nitre, or whether the quartz may not, like alum, acquire its property of crystallizing from the addition of some other substance. This question, as he remarks, must be resolved by future experimental enquiries.

The analysis of the whitish spots afforded silex 98 grains, oxide of iron 1, carbonate of lime 2. That of the absolutely opake parts gave five parts more of carbonate of lime; and lastly, the analysis of the white coating naturally enveloping the masses, afforded 86 parts of silex, 1 oxide of iron, 10 carbonate of lime, and 3 loss. Those analyses which afforded no alumine, shew that this earth is not essential to the silex, and the absence of lime in the first analysis shews that it was an accidental ingredient in the latter.

Mineralogical situation. In France in the environs of St. Aignan, situated in the department of Loir-Cher, and in that of L'Indre, and the departments which occupy the vallies of Siene and Marne, are principally the places where this stone is found. It exists in the chalky calcareous stones, in chalks more or less fine and solid, and in marles. They form horizontal strata, by the manner in which the large and small masses are placed beside each other. Nevertheless, as the blocks of silex do not accurately touch each other, there is no solution of continuity between the upper and lower masses of chalk.

Out of twenty beds of silex lying one above the other, at a distance of twenty feet or less, there will frequently be no more than one, and very seldom two, which afford good stones of this description; but in the bed which affords them, almost all the blocks have a greasy appearance, and in the other strata scarcely any of this description will be found. Accordingly the good strata are followed

by subterraneous excavations, frequently at considerable expence, while the others are neglected.

On the banks of the Cher the flints are explored in a plain, by digging shafts to the depth of 40 or 50 feet, from whence horizontal galleries are carried into the only good stratum which is known.

On the banks of the Seine in the hills of La Roche Guion, the cliffs of chalk present steep precipices, where the strata of silex are exposed; and one of these strata, which contains good stones for gun-flints, is about six toises from the upper surface of the great mass of chalk.

Instruments.

The instruments used for fashioning the gun-flints are four in number:

1. A small piece of iron or mace, with a square head, Plate 1. Fig. 1. the weight of which does not exceed two pounds, or perhaps a pound and a half, with a handle seven or eight inches long. This instrument is not made of steel, because if it were too hard, its stroke might shatter the flint, instead of breaking it by a clear fracture.

2. A hammer with two points, in which the position of the points is of consequence as to the nature of the stroke, Fig. 2. This hammer, which must be of good steel well hardened, and does not weigh more than sixteen ounces; some do not exceed ten. It is fixed on a handle seven inches long, which passes through it in such a manner, that the points of the hammer are nearer the hand of the workman, than the center of gravity of the mass. The form and size of the hammers of different workmen vary a little, but this disposition of the points is common to them all, and is of consequence to the force and certainty of the blow.

3. A little instrument named Roulette (roller) which represents a solid wheel, or segment of a cylinder, two

inches and one third in diameter. Its weight does not exceed twelve ounces, it is made of steel not hardened, and is fixed on a small handle six inches long, which passes through a square hole in its center.

4. A chissel bevelled on both sides, seven or eight inches long, and two inches wide, of steel not hardened; it is set on the block of wood which serves as a work bench, out of which it rises to the height of four or five inches. To these four instruments we may add a file, for the purpose of restoring the edge of the chissel from time to time.

The process:

After selecting a good mass of silex, the whole operation may be divided into four manipulations.

1. To break the block. The workman being seated on the ground, places the flint on his left thigh, and strikes it gently with the larger hammer, Fig. 1. to divide it into portions according to its size, that is to say, of about a pound and a half each, with broad surfaces nearly flat. He is careful not to crack or produce shakes in the flint by striking it too hard.

2. To cleave the flint, or break it into scales. The principal operation of this art is to cleave the flint well: that is to say, to separate from it pieces of the length, thickness, and figure, adapted to be afterwards fashioned into gun-flints; and in this part the greatest degree of address, and certainty of manipulation are required. The stone has no particular direction in which it can be most easily broken. The course of its fracture depends entirely upon the choice of the workman. In this process he holds a piece of flint in his left hand, not supported, and strikes with the hammer, Fig. 2. on the broad faces produced by the first fracture, in such a manner as to chip off the white coating of the stone in small scales, and to lay bare the silex in the manner represented, Fig. 5.;

after which he continues to strike off other similar portions of the pure silex. These pieces are nearly an inch and a half wide, two inches and a half long, and one sixth of an inch thick in the middle.

They are slightly convex within, and consequently leave a space somewhat concave, terminating longitudinally in two lines, somewhat projecting, and nearly strait. The prominent edges produced by the fracture of the first scales, must afterwards constitute nearly the middle of the subsequent pieces; and those pieces only, in which they are found, can be used to form gun-flints.

In this manner the operator continues to cleave, or scale the stone in different directions, until the natural defects of the mass render it impossible to make the fractures required, or until the piece is reduced too much to receive the small blows which separate the pieces.

3. To fashion the flint.

The gun-flint, Fig. 7. may be distinguished into five parts, namely, 1. the edge, or bevel part, which strikes the hammer or steel. This is two or three twelfths of an inch in width. If it were broader it would be too liable to break, and if more obtuse it would not afford a brisk fire. 2dly. The side edges, which are always somewhat irregular. 3dly. The back edge, most remote from the hammer where the stone possesses its intire thickness. 4thly. The under surface, which is smooth and slightly convex. And 5thly. The upper face, which is slightly concave, and receives the action of the upper claw of the cock, in which it is fixed for service.

In order to fashion the stone, those scales or chips are selected, which have at least one longitudinal prominent angle. One of the two edges is fixed on to form the striking edge; after which the two sides of the stone which are to form the side edges, and that which is to form the hinder edge are successively placed with the convex sur-

face upon the edge of the chissel, which is supported with the fore-finger of the left hand, at the same time that a small blow or two is given above the point of support with the Roulette, Fig. 3. by which the stone breaks exactly along the edge of the chissel, as if it had been cut. In this manner the sides and posterior edge of the stones are made.

4. The stone being thus reduced to its proper figure, the finishing operation consists in completing its edge in a strait line. For this purpose the stone is turned, and the under flat part of the edge is placed on the chissel, in which situation it is completed by five or six small strokes with the Roulette.

The whole operation of fashioning a gun-flint is performed in less than one minute.

A good workman can prepare a thousand good chips or scales in a day, if his flints be of good quality, and he can also fashion five hundred gun-flints in a day; consequently in three days he will cleave and finish a thousand gun-flints without further assistance.

This manufacture leaves a great quantity of refuse; that is to say, about three-fourths of the whole stone. For there are not more than half the scales which prove to be well figured, and nearly half the mass in the best flints is incapable of being chipped out: so that it seldom happens that the largest piece will afford more than fifty gun-flints. The larger pieces of refuse are sold for the culinary purpose of striking a light.

The gun-flints when completed are sorted out, and sold at different prices, according to their degrees of perfection, from 4 to 6 decimes (or pence) the hundred. They are classed into fine flints and common flints; and according to their application into flints for pistols, fowling pieces, and muskets.

The fabrication and commerce of gun-flints in France

is in some measure confined to three communes of the department of Loir-et-Cher, and one department of the Indre, as was before mentioned, namely, the commune of Noyers, 2,400 metres east north-east of St. Aignan; the commune of Couffy at 5,600 metres, and that of Meunes at one miriameter east south-east, and in the latter department, the commune of Lye 9 kilometers to the south-west of St. Aignan. The inhabitants of these communes employed in this species of industry are about 800, and they have excavated great part of the plain they inhabit.

A single workman named Stephen Buffet, who emigrated from the commune of Meunes to the banks of the Seine, where he has carried on this art for about thirty years by himself, was the person from whom Dolomieu obtained the present instructions. There are a few other places in France where this art is practised, but in none to the extent of the places before mentioned. The author has not met with this manufactory in any other countries, except in the territory of Vicenza, and one of the cantons of Sicily. He remarks that it may be carried on elsewhere, though probably overlooked by travellers, on account of its apparent insignificance. I believe it is practised at Purfleet, in the county of Kent, and in various other parts of England.

## No. 5.

### *Wooden Matches for Artillery to be used instead of Rope Match, or Port-Fires: read at the National Institute, April* 1806. *By* C. L. CADET.*

FOR several centuries rope match only was used for firing great guns, mortars, howitzers, and other pieces of artillery. This match, as is well known, is a rope of supple hemp, of a midling size, boiled for two hours in a bath of saltpetre, ashes, quicklime, and horse-dung. This rope, when dried, burns slowly to the end, in the manner of touchwood, and communicates its fire like red-hot coal. For use it is twisted round a staff called a port-match, and left to project near five inches beyond its end, this length burning an hour.

This match has several inconveniences. It requires constant attendance, since it must be unrolled from the staff every hour, or oftener; a tolerably heavy rain puts it out; it gives the artilleryman no light by night; and the end beyond the staff is not always steady, so that the gunner is slow in firing his piece. On these accounts its use is now confined to garrisons, except for carrying fire in the field, where for other purposes port-fires are employed.

These port-fires are paper tubes, filled with a mixture of sulphur, saltpetre, and a very little neat-powder. This composition, the greater part of which is saltpetre, burns and melts with great activity, giving a vivid and bright flame, which quickly sets fire to the priming. In this respect they are far preferable to match, since they give light to the gunner, their fire is more vivid, and they are more easily guided; but these advantages are counter-

* Nicholson, v. 17. p. 31. from *Annales de Chimie*, Sep. 1806, p. 314.

balanced by dangers and defects. The saltpetre in these port-fires is never entirely burnt, but part runs out of the tube. When the materials are not well powdered, they are subject to spit, or throw out pieces of burning saltpetre to the distance of three or four feet, which may occasion serious accidents, particularly on board ships. I myself had my hair set on fire, and a hole burnt through both my coats, by a spark of this kind. In ships they are obliged to be kept in the middle of a tub of water on this account.

These were the only means employed to fire pieces of artillery, when one of my correspondents at Madrid acquainted me, that Messrs. Borda and Proust had proposed to the Spanish government, to substitute instead of the cannon match, wooden rods impregnated with nitrate of copper. He added, that these rods burnt like touchwood, forming a pointed red coal; and that the trials with them succeeded perfectly, though they had not been adopted. I informed his excellency, the minister at war, of this new method; and he requested me to make the necessary experiments for ascertaining its utility, directing Mr. Lespagnol, a captain in the artillery, to assist me in the inquiry.

My first idea was, that all kinds of wood could not be equally fit for the purpose; and that the difference of their porosity would occasion a difference in their combustibility. Before I tried the metallic nitrates, I took common saltpetre, and boiled several kinds of wood in a strong solution of it, which they imbibed in different proportions. This attempt did not succeed: the only wood that burnt quickly was the common cane, used for dusting clothes, or *rotang;* but its coal had no substance, the least blow breaking it off, and extinguishing it. I then got a joiner to make me some square rods, half a yard long, of oak, elm, ash, elder, birch, poplar, lime,

and fir. I took two parcels of these, and boiled one in a solution of nitrate of copper, the other in a solution of nitrate of lead. In each, the oak, elm, ash, and elder, were not saturated, and burnt in the usual manner: the others afforded me very good matches. But before I enter at large on their properties, I shall observe, that I conceive the nitrate of copper should be rejected, because it is too dear, it quickly corrodes the boilers, and its vapour is noxious. Accordingly I confined myself to the nitrate of lead; and I found after several trials, that it answered the purpose completely.*

The wood that did best was that of the lime, birch, or poplar. To compare their properties, I weighed some rods both before and after boiling; I ascertained how much their weight was increased, and how long they continued burning; and I calculated how much of each a pound of nitrate of lead would saturate. The following table gives the proportions.

| Name of the wood. | Weight of a yard before the experiment. Grains. | Weight after. Grains. | Gained in Weight. Grains. |
|---|---|---|---|
| Birch | 888 | 1416 | 528 |
| Poplar | 516 | 936 | 420 |
| Lime | 888 | 1728 | 840 |

| Name of the wood. | Length saturated by a pound of nitrate of lead. Yards. | Ft. | Inches. | Time each continued burning. Hours. |
|---|---|---|---|---|
| Birch | 17 | 1 | | 3 |
| Poplar | 21 | 2 | 8 | 2 |
| Lime | 10 | 2 | 9 | 3 |

* If this plan should be adopted by our government, and comparative experiment should prove the nitrate of copper to be preferable to that of lead, an easy method of manufacturing that salt might be pursued, viz. the decomposition of sulphate of copper, by nitrate of potash.—Here the objections made by the author would be avoided—and the expense attending much lessened. By a small experiment made with this view, I have reason to believe every object wished for may be attained. Ed.

From this comparative trial it follows, that the lime tree affords the best wood for matches for artillery; and with it I made the experiments desired by the minister, in presence of Mr. Lespagnol.

There are circumstances in which the service of the artillery requires light. Rods impregnated merely with nitrate of lead, produce a coal sufficient to discharge a cannon, but no light is afforded by them. I conceived, that, if they were impregnated with oil of turpentine, they might yield flame, without detriment to the action of the nitrate: and my hopes were realised, for rods thus prepared furnished both light and fire at pleasure. In this addition I found two other advantages: one, that of rendering the wooden match impervious to water; the other, that of facilitating the reduction of the lead, part of which I was apprehensive might be carried off in vapour, and injure the health of those who respired it.

The theory of the process I adopted is simple; and it is easy to explain, why metallic nitrates succeed better than nitrate of potash. However dry the wood may be, it always retains a little of its water of vegetation or of composition, which is an obstacle to its proper combustion. By boiling the rods in a solution of nitrate of lead or of copper, which on account of its specific gravity requires a high temperature; this fluid dilates, softens, and penetrates the fibres of the wood, and expels their water of vegetation, which is replaced by that of crystallization. The nitrate then comes into immediate contact with the carbon of the wood, whence the rapidity of its combustion. The nitrate of potash does not answer so well, because, retaining much water of crytallization, its solution does not acquire so high a temperature: and, supposing it able to penetrate the wood as intimately, it carries into it too much water, for its combustion to be progressive and continual. A proof of this reasoning

may be found in the composition of the two salts: nitrate of lead contains .75 of its base, that of potash but .49.

The rapid combustion of the wooden match is owing also to the facility with which the salts of lead are reduced, when in contact with burning charcoal. If a hempen rope be boiled in a solution of acetate of lead, and afterward dried, it may be used as a match. It burns slowly like touchwood, and has a very bright coal. The oxide of lead, as the metal is reduced, gives out its oxigen to the carbon, and accelerates the combustion.*

On comparing the specific gravity of wood with its saturation by salts, we find, that the lighter the wood, the more saline matter it absorbs into its pores, or the interstices of its fibres. Hence it appears to me we may infer, that it contains less carbon than a heavier wood in a given bulk; and that its combustion will evolve less caloric, since the caloric emitted is in the ratio of the quantity of oxigen combined with the combustible. It seems to me, that we might class different kinds of wood, as to their combustibility, by their absorption of salts; and thus find which would be most advantageous to burn for domestic purposes, whether we would have a rapid combustion, or a stronger and more continued heat. These researches will form the subject of a particular work, which I purpose on all our forest trees.

The wooden matches, compared with port-fires, have the following advantages.

The port-fire lasts but three or four minutes.

A match a yard long will burn three hours.

The port-fire is liable to break in the boxes.

The match is strong, and easily carried about.

The port-fire throws out dangerous sparks:

* We have a familiar instance of this in the popular experiment of burning a red wafer in the flame of a candle.

The match confines its fire to itself.

The port-fire costs from three pence to four pence half-penny:

The match costs but three half-pence or two-pence.

The last consideration is of great importance, since, from calculations made in the war-office, what would cost the state in the one case a thousand pounds, in the other would not come to more than seventy-five.*

As it was necessary to ascertain, whether these new matches would resist the rain, I had several burnt during long and heavy rains, and they were not extinguished till they were totally consumed; their combustion being a little retarded only.

As the fabrication of these matches requires some care and precaution, I shall conclude this paper with a minute description of the process, agreeably to the request of his excellency the minister at war, for the instruction of the artificers employed in our arsenals.

*Method of preparing the combustible wooden Matches for Artillery.—Shape of the Matches and choice of Wood.*

The matches should be parallelopipedons, half a yard long, and half an inch square. The best wood for them is that of the lime tree, or birch; but for want of these, poplar or fir may be used. Any white and soft wood might be taken, if necessary; but those above-mentioned are to be preferred.

The shape might be supposed of no consequence: yet experience proves, that round matches do not furnish so good a fire as the square. The angles of the latter keep the coal in the centre burning vividly, and the match always terminates in a burning cone two inches long.

* According to the estimates just before given, the saving would be much greater than this on the lowest calculation. T.—[And still more so, if the plan proposed in a former note should be found to answer. Ed.]

### *Drying the Wood.*

Before the matches are saturated with nitrate of lead, the wood must be perfectly dry. For this purpose the wood should have been cut and stored at least a twelvemonth; and the matches, after they are shaped, be exposed for half a day to the heat of a stove at 30° (by what thermometer is not mentioned; probably 90°, or perhaps 100° Fh.) For want of a stove they may be put into a baker's oven, when the bread is drawn.

### *Furnaces and Boilers.*

The fabrication of the matches requires two furnaces and two boilers, The shape of the boilers should be that of a fish-kettle, narrow, and three quarters of a yard long. Their size should be proportional to the quantity to be made at a time. The furnaces should be constructed so that the heat may act uniformly on every part of the bottom of the boiler. The first boiler must be of copper, well tinned, and provided with a plate of the same metal, to press down the matches, and keep them immersed in the boiling solution. The second boiler may be either of copper or of cast iron, placed on a sand bath, and having no direct communication with the fire. It should have a lid fitted to it very closely; and handles to lift it up when necessary.

### *Preparation of the Nitrate of Lead.*

To make this salt, nitric acid, or aqua fortis, must be saturated with red oxide of lead, or with litharge: but as it is necessary that the salt should be neutral, and have no excess either of acid or of base, some precautions in this operation are necessary. If the acid be too much concentrated, the salt will unite in a mass, crystallize confusedly, and contain a great deal of uncombined ox-

ide. If too little oxide be used, the salt will be acidulous, and soon destroy the boilers. To obtain the mean term, 500 parts of litharge should be put into a vessel of glass or earthen ware, and on this should be poured 416 parts of nitric acid at 40°, (specific gravity, we believe, 1.386) diluted with 128 parts of water; heat the mixture till the oxide is dissolved, filter, and evaporate to dryness. These proportions ought to produce 640 parts of lead.

### *Bath of Nitrate of Lead.*

The nitrate of lead is very soluble in water, and the least possible quantity of liquid should be employed, that the bath, fully loaded, may acquire a temperature far beyond that of boiling water, and thus insinuate itself easily into the pores of the dilated wood. Accordingly, for every pound of nitrate, only a wine quart of water should be put into the boiler, or thereabout: but as different kinds of wood do not saturate themselves equally with the salt, their proportions must be studied. Experiment has shewn that to absorb a pound of nitrate of lead, requires near eleven yards of lime wood, 17½ of birch, and near 22 of poplar. The lime therefore, when saturated is the most combustible.

To render the saturation of the wood complete, six hours boiling are necessary, and hot water must be added, when the bath sinks so low as to let the salt fall to the bottom.

### *Second Drying of the Matches.*

When the matches are taken out of the boiler, they must be carried to the stove, and made thoroughly dry, before they are put into the following bath.

### *Turpentine Bath.*

Into the second boiler is to be put as much oil of turpentine, as will cover the matches to the depth of about an inch; and this is to be heated gently, till it begins to boil. But the moment it grows white and rises, the boiler must be covered, and quickly lifted off the sand bath, lest the oil should take fire. This boiling should be repeated two or three times, which will take about half an hour: the bath then is to be left to cool; the matches are to be taken out and wiped; and lastly they are to be dried in the stove, when they will be ready for use.

This paper was approved by the Institute, at its meeting on the 5th of May, on the report of Messrs. Carnot, Deyeux, and Guyton de Morveau.

## *No.* 6.

[In the accounts of the numerous fires which occur in the United States, it is very common to ascribe them to the nefarious proceedings of some unknown incendiary. Although this may often be the case, yet it is incumbent upon us, before stigmatizing our countrymen with such diabolical proceedings, to ascertain, if in many instances, domestic carelessness, &c. is not the source. The following papers will tend to prove, that fires may spontaneously originate from causes little suspected—and may possibly operate in promoting due attention to prevent many fatal accidents of this description.* Ed.]

* Since I put this paper into the hands of the printer, I have seen in the last number of the Medical Repository, a paper of Dr. Seybert upon this very interesting subject of spontaneous combustion. It is my intention to bring together in this and the following numbers, all the facts which have been noticed respecting it. Their importance demands that they should be concentrated into a point. Ed.

*Account of a violent Explosion which happened in a Flour Warehouse, at Turin, December the 14th, 1785; to which are added some observations on spontaneous Inflammations. By* Count MOROZZO.*

THE Academy having expressed a desire to have a particular account of the explosion which I mentioned to them a few days after it happened, I have made all possible haste to fulfil their desires, by ascertaining with the utmost attention, all the circumstances of the fact, so as to be able to relate it with the greatest exactness.

I shall take the liberty to add to it a short account of several spontaneous inflammations, which have happened to different substances, and which have been the cause of very great misfortunes. Although the greater number of these phenomena is already well known to philosophers, I trust the collecting them together in this place will not be displeasing, as it is impossible to render too well known facts which so strongly interest the public utility.

On the 14th of December, 1785, about six o'clock in the evening, there took place in the house of Mr. Giacomelli, baker in this city, an explosion which threw down the windows and window-frames of his shop, which looked into the street; the noise was as loud as that of a large cracker, and was heard at a considerable distance. At the moment of the explosion, a very bright flame, which lasted only a few seconds, was seen in the shop; and it was immediately observed, that the inflammation proceeded from the flour-warehouse, which was situated over the back shop, and where a boy was employed in stirring some flour by the light of a lamp. The boy had

* Repert. of Arts, vol. ii. p. 416. From the Memoirs of the Academy of Sciences of Turin.

his face and arms scorched by the explosion; his hair was burnt, and it was more than a fortnight before his burns were healed. He was not the only victim of this event; another boy, who happened to be upon a scaffold, in a little room on the other side of the warehouse, seeing the flame, which had made its passage that way, and thinking the house was on fire, jumped down from the scaffold, and broke his leg.

In order to ascertain in what manner this event took place, I examined, very narrowly, the warehouse and its appendages; and, from that examination, and from the accounts of the witnesses, I have endeavoured to collect all the circumstances of the event, which I shall now describe.

The flour-warehouse, which is situated above the back shop, is six feet high, six feet wide, and about eight feet long. It is divided into two parts, by a wall; an arched cieling extends over both, but the pavement of one part is raised about two feet higher than that of the other. In the middle of the wall is an opening of communication, two feet and a half wide, and three feet high; through it the flour is conveyed from the upper chamber into the lower one.

The boy, who was employed, in the lower chamber, in collecting flour to supply the bolter below, dug about the sides of the opening, in order to make the flour fall from the upper chamber into that in which he was; and, as he was digging, rather deeply, a sudden fall of a great quantity took place, followed by a thick cloud, which immediately caught fire, from the lamp hanging to the wall, and caused the violent explosion here treated of.

The flame shewed itself in two directions; it penetrated, by a little opening, from the upper chamber of the warehouse, into a very small room above it, where, the door and window-frames being well closed and very

strong, it produced no explosion: here the poor boy, already mentioned, broke his leg. The greatest inflammation, on the contrary, took place in the smaller chamber, and, taking the direction of a small staircase, which leads into the back shop, caused a violent explosion, which threw down the frames of the windows which looked into the street. The baker himself, who happened then to be in his shop, saw the room all on fire some moments before he felt the shock of the explosion.

The warehouse, at the time of the accident, contained about three hundred sacks of flour.

Suspecting that this flour might have been laid up in the warehouse in a damp state, I thought it right to enquire into that circumstance. I found, upon examination, that it was perfectly dry; there was no appearance of fermentation in it, nor was there any sensible heat.

The baker told me that he had never had flour so dry as in that year (1785), during which the weather had been remarkably dry, there having been no rain in Piedmont for the space of five or six months: indeed, he attributed the accident which had happened in his warehouse to the extraordinary dryness of the corn.

The phænomenon, however striking at the time it happened, was not entirely new to the baker, who told me that he had, when he was a boy, witnessed a similar inflammation; it took place in a flour-warehouse, where they were pouring flour through a long wooden trough, into a bolter, while there was a light on one side; but, in this case, the inflammation was not followed by an explosion.

He mentioned to me several other instances, which I thought it my duty to enquire into; amongst them, one which had happened to the widow Ricciardi, baker in this city, where (there being, on the other side of the wall of the flour-warehouse, a lock-smith's forge) the

flour was heated to such a degree, that a boy who went into the warehouse could not remain there, so much were his feet scorched by the heat; this flour was of a dark brown colour, and whilst the people were examining it, sparks began to appear, and fire spread itself around, without producing any flame, like a true *pyrophorus*.*

He also informed me, that an inflammation like that above-mentioned had happened at the house of a baker in this city, called Joseph Lambert; it was occasioned by shaking some large sacks, which had been filled with flour, near a lighted lamp, but the flame, though pretty brisk, did not do any mischief.

According to the foregoing accounts, it appears to me, that it is not difficult to explain the phænomenon in question. The following is the idea I have conceived of it: as the flour fell down, a great quantity of inflammable air, which had been confined in its interstices, was set free; this, rising up, was inflamed by the contact of the light; and, mixing immediately with a sufficient quantity of atmospheric air, the explosion took place on that side where there was the least resistance. As to the burning of the hair, and the skin, of the boy who was in the warehouse, the cause of it must be attributed to the fire of the fine particles of the flour, which, floating in the atmosphere, were kindled by the inflammable air, in the same manner as the powder from the stamina of certain vegetables, (particularly of the pine and of some mosses) when thrown into the air takes fire, if any light is applied to it.

But it may be objected, that as the flour was not at all

* I was very anxious to ascertain by experiments, whether it were possible to bring flour alone into the state of pyrophorus, but it was in vain; for though I calcined flour with a strong heat, in a small retort, with the same precautions as are used in making other *pyrophori*, I never could succeed in making it take fire by exposure to the air. By joining alum with it I obtained a true pyrophorus, as Lemery had already done.

damp, and had not any sensible degree of heat, there should not be any fermentation in it, and consequently no inflammable air should be produced: to this I answer,

First. That flour is never entirely free from humidity, as is evidently shewn by distillation.

Secondly. That although the degree of heat was not so great as to set free inflammable air by fermentation, a sufficient quantity was set free, by what may be called a mechanical mean, to inflame upon the contact of light; and to disengage, at the same time, all that which communicated with the atmospheric air.

Thirdly. We must recollect that flour also furnishes alkaline inflammable air, which is produced from the glutinous vegeto-animal part of the corn; and we know that this kind of inflammable air is of a very active nature.

After having described this singular event, I shall beg leave to collect together, in this place, all the known facts respecting spontaneous inflammations produced by different substances. A circumstantial account of these phænomena cannot but be very interesting to those concerned in government; not only as it may tend to prevent the unhappy accidents which result from them, but also as it may sometimes hinder the suspicion and persecution of innocent persons, on account of events which are produced merely by natural causes.

I shall not mention the inflammations caused by lightning, by subterraneous fires, and by other meteors; they are not of the nature of those of which I mean to speak, but I shall not pass over in silence the spontaneous combustions of human bodies. Though events of this kind are very rare, yet we have some examples of them recorded in the Philosophical Transactions, and in the memoirs of the academies of Paris and of Copenhagen. It is there related, that an Italian lady (the countess

Cornelia Bandi) was entirely reduced to ashes, except her legs; that an English woman called Grace Pitt, was almost entirely consumed by a spontaneous inflammation of her viscera; and, lastly, that a priest of Bergamo was consumed in the same manner. These spontaneous inflammations have been attributed to the abuse of spirituous liquors; but, though the victims of intemperance are indeed very numerous, these certainly do not belong to that number.

The spontaneous inflammation of essential oils, and that of some fat oils, when mixed with nitrous acid, are well known to philosophers; so also is that of powdered charcoal with the same acid; (lately discovered by M. Proust;) and those of phosphorus, of pyrophorus, and of fulminating gold. These substances are generally to be found only in the laboratories of chemists, who are perfectly well acquainted with the precautions which it is necessary to take, to prevent the unhappy accidents which may be occasioned by them.

The conflagration of a frigate, belonging to the Empress of Russia, in the harbour of Cronstadt, on board of which there had been no fire, shews that lamp black, by being moistened with hemp-seed oil, is capable of producing flame; this was proved by the experiments which the Academy of Petersburgh made upon the subject, by order of the Empress; and, though the gentlemen of the academy could not succeed in producing inflammation in hemp or cordage, by wetting them with the foremention-ed oil, it is still very probable that the terrible fire which happened in the great magazine of cordage at Petersburgh, was occasioned by the spontaneous inflammation of these substances; and also that which happened at Rochefort in the year 1756.*

The burning of a store-house of sails, which happen-

* A more particular account of several of these facts, will appear in our subsequent numbers. Ed.

ed at Brest, in the year 1757, was caused by the spontaneous inflammation of some oiled cloths, which, after having been painted on one side, and dried in the sun, were stowed away while yet warm, as was shewn by subsequent experiments.*

Vegetables boiled in oil or fat, and left to themselves, after having been pressed, inflame in the open air. This inflammation always takes place when the vegetables retain a certain degree of humidity; if they are first thoroughly dried, they are reduced to ashes, without the appearance of flame. We owe the observation of these facts to MM. Saladin and Carette.†

The heaps of linen rags which are thrown together in paper manufactories, the preparation of which is hastened by means of fermentation, often take fire if not carefully attended to.

The spontaneous inflammation of hay has been known for many centuries; by its means, houses, barns, &c. have been often reduced to ashes. When the hay is laid up damp, the inflammation often happens; for, the fermentation is then very great. This accident very seldom occurs to the first hay, (according to the observation of M. de Bomare,) but is much more common to the second; and if, through inattention, a piece of iron should be left in a stack of hay in fermentation, the inflammation of that stack is almost a certain consequence. On this subject, an excellent memoir of M. Sennebier‡ may be consulted. Corn, heaped up, has also sometimes produced inflammation of this nature; Vanieri, in his *Prædium Rusticum*, says,

*Quæ vero (gramina) nondum satis insolata recondens*
*Imprudens, subitis pariunt incendia flammis.*

* See Mémoires de l'Académie de Paris. 1760.

† Journal de Physique. 1784.

‡ Journal de Physique, 1781.

Dung also, under certain circumstances, inflames spontaneously.

We have likewise examples of spontaneous inflammations in the productions of the animal kingdom. Pieces of woollen cloth, which had not been scoured, took fire in a warehouse. The same thing happened to some heaps of woollen yarn; and some pieces of cloth took fire in the road as they were going to the fuller. These inflammations always take place when the matters heaped up preserve a certain degree of humidity, which is necessary to excite a fermentation; the heat resulting from which, by drying the oil, leads them insensibly to a state of ignition; and the quality of the oil, being more or less desiccative, very much contributes thereto.

The mineral kingdom also often affords instances of spontaneous inflammation. Pyrites heaped up, if wetted and exposed to the air, take fire. Pit-coal also, laid in heaps, under certain circumstances, inflames spontaneously. M. Duhamel has described two inflammations of this nature, which happened in the magazines of Brest, in the years 1741 and 1757.*

Boats loaded with quick lime have taken fire as they sailed along; and lime, by being wetted, has often set fire to substances which happened to be near it.

Cuttings of iron, which had been left in water, and were afterwards exposed to the open air, gave sparks, and set fire to the neighbouring bodies. For this observation we are obliged to M. de Charpentier.

The explosion of a powder mill, which happened in the year 1784, in the royal manufactory of Turin, the cause of which could not be discovered, may perhaps have been occasioned by the spontaneous inflammation of the ingredients of which gunpowder is made, as Count de

* Mémoires de l'Académie.

Saluces suspected. I do not however deny the possibility of its having been caused by the meteor which was supposed to have been the occasion of it; for, there is a kind of hepatic air continually arising from those ingredients, when wetted with water, and the least flame is sufficient to kindle this aëriform vapour.

It is very evident, from the facts which I have related, that spontaneous inflammations being very frequent, and their causes very various, too much attention and vigilance cannot be used to prevent their dreadful effects. And consequently it is impossible to be too careful in watching over public magazines and storehouses, particularly those belonging to the ordnance, or those in which are kept hemp, cordage, lamp-black, pitch, tar, oiled cloths, &c. which substances ought never to be left heaped up, particularly if they have any moisture in them. In order to prevent any accident from them, it would be proper to examine them often, to take notice if any heat is to be observed in them, and, in that case, to apply a remedy immediately. These examinations should be made by day, it not being advisable to carry a light into the magazines, for, when the fermentation is sufficiently advanced, the vapours which are disengaged by it, are in an inflammable state, and the approach of a light might, by their means, set fire to the substances whence they proceed.

Substances in fermentation are very often unable to inflame of themselves, but the simple contact of flame is sufficient to kindle them rapidly, as many examples demonstrate; so that we might make a separate class of those substances in which inflammation cannot take place of itself, but which are set on fire by the approach of flame; of this we have an example in the accident which happened in the flour-warehouse.

Ignorance of the fore-mentioned circumstances, and a

culpable negligence of those precautions which ought to be taken, have often caused more misfortunes and loss than the most contriving malice; it is therefore of great importance that these facts should be universally known, that public utility may reap from them every possible advantage.

[*To be continued.*]

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## *No. 7.*

### *Description of a moveable Table, for the Use of Engravers; invented by the* Abbé Joseph Longhi, *of Monza.**

With an Engraving.

THE art of engraving upon copper, which was at first invented to multiply and preserve copies of the best pictures of the most able painters, and portraits of the most famous men, and which has ever since its invention been much esteemed, is at present in such repute in every civilized nation, that its productions are become of great consequence, even when considered as an article of commerce; and, when this art is followed by young men who have both an iuclination and a genius for it, what advantage may it not produce to their country, and to society in general? But it often happens, as history testifies, that those artists who apply the most assiduously to it fall early victims to their assiduity, so that their first essays become their last works. I myself remember, with great concern, several who have been taken from this world by a death more or less premature. Considering what could be the cause of this evil, as it was by no means difficult to discover, I found it to proceed from the

* Repert. of Arts, vol. v. p. 354. From the Transactions of the Patriotic Society of Milan. A gold medal was given to the Abbé Longhi for this invention.

Fig. 1.


Fig. 4.

Fig. 2.

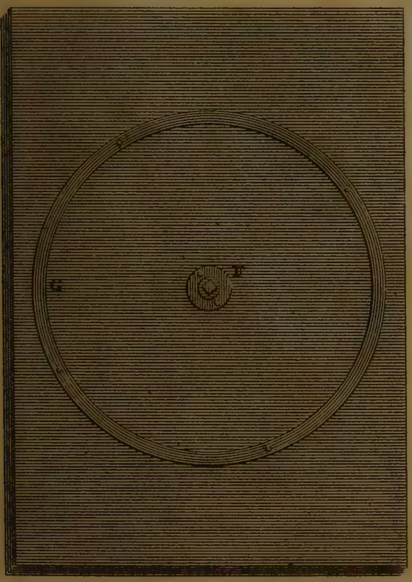
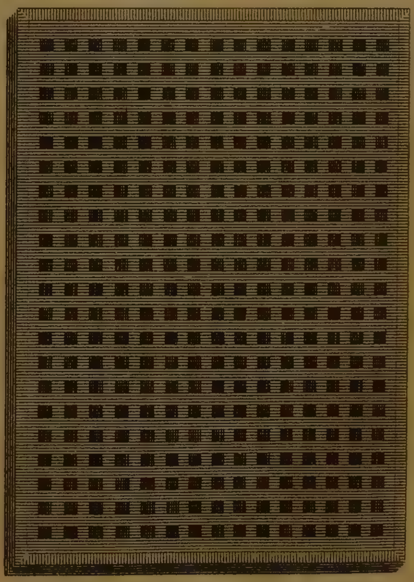



Fig. 3.



y hurtful attitude in which the engraver is placed ile he is at work; for, in engraving a plate, even of a ldling size, if the plate be placed horizontally upon a hion, as is usual, it is impossible to perform the work hout a very injurious curvature of the body; which, being repeated as often as is necessary in the course the operation, lays the foundation of those complaints ich so often prove fatal to artists. It is however cer- 1 that, besides this cause, many others may have con- uted to those disorders which have deprived us of ma- excellent engravers, but the most evident cause is in art itself. Wherefore, instead of being surprised at ir unhappy fate, I cannot help considering those who e lived to an advanced age as wonderful instances; a y strong constitution, (which, however, is seldom the of those who have great talents) taking exercise, less iduity in their labour, and a power of performing their rk without carrying their eyes very near it, may have mpted them from the common fate of their fellow- sts.

nstead of trusting to these infrequent examples, I ught I should do a more useful thing by contriving h a table, for the use of engravers, as is here describ- My intention was that those artists should be able to rk, either standing or sitting, without bending the bo- ; for that reason I began by placing the copperplate on a desk. It was then necessary to be able to turn it ut as occasion required: for this purpose, a pivot or s in the centre, upon which it might revolve, would ice; but I soon found that, upon one centre, it would be possible to execute properly the various lines, in many different directions as would be required. It ame therefore also necessary that the board, upon ich the plate was to be fixed, should have a great

number of holes underneath, by which it might be put upon the axis or pivot in any part, as occasion might require; and as these holes, if made of a circular form, would perhaps not be all exactly of the same size, (either from the difficulty of making them so originally, or from some of them being oftener made use of than others) which consequently would take from the machine that steadiness which the artist always finds essential to his work, I thought it would be better to make them square, and, of course, to make that part of the axis which fits into them square also. Below this square part, the axis is round, and turns in a socket, so that there is no danger of its becoming either too loose or too tight. In this manner I had a table made, and I find it to answer the purpose for which it was intended in the most complete manner. Indeed, I find it much more commodious for engraving than any other method; for, when it is necessary to engrave in the corner of a plate, if we turn the plate upon a cushion, and support it with the left hand, (as is the usual way,) that hand finds it difficult, from the weight of the plate, to keep it quite motionless; and the smallest motion in the plate renders it impossible to perform the work properly, consequently that part of the plate is worse executed than the rest: but, upon my table, where the plate is fixed upon a pivot or axis, and supported by a projecting part under it, the left hand has much less to do, and the plate always turns round parallel to what it rests upon.

Thus I have given an account of the motives which induced me to contrive this table, and of the manner in which I have executed it. It has been approved by Signor de Vangelisty, professor of engraving at Milan, (who, upon seeing it, immediately made trial of it) and by the Imperial Academy of Vienna; I therefore take

the liberty to present the foregoing account of it to the Patriotic Society, with a figure of it, trusting it will be found not less useful to artists than to the art itself.*

Plate 2. fig. 1. represents the whole machine, as it is used.

A. Copper-plate on which the engraving is to be made.

*a a a a a a a a.* Screws by which the plate is affixed to the movable board B.

B. The upper or movable part of the table. It consists of a thin plank, to the bottom of which is united the iron plate represented in Fig. 3.

C. The under-board, which is made to rise and fall at pleasure, in the manner of a desk, by means of a pair of hinges; in the middle of it is a pretty thick axis.

D. The foot by which the desk is supported at any required height.

E. The frame of the table.

Fig. 2. The under-board or desk.

F. A circle of iron, through the middle of which protrudes that part of the axis marked H. (In Fig. 4.)

* [I am happy to have it in my power to confirm the value of the above paper, by the following testimonial of some of our best engravers. Ed.]

*Philadelphia, April* 27, 1812.

Sir,

We have lately seen the plan of a Table invented by the Abbé Joseph Longhi, of Monza, for the use of Engravers, and upon examination of the same, we are of opinion that the invention is not only very ingenious, but also extremely well calculated for the purpose intended. We are, sir, yours, &c.

GEO. MURRAY.
CORNs. TIEBOUT.
FRANCIS KEARNEY.
WILLIAM KNEASS.
D. EDWIN.

Dr. Coxe.

G. A larger circle of iron, of the same height as the circle F; it serves for the movable board B to rest upon, as it is turned round.

Fig. 3. The movable board B, with the iron plate fixed to it. The square holes in this plate must exactly fit that part of the axis which protrudes; and the plate itself must project so much from the board, as to take in the said part of the axis conveniently.

Fig. 4. The axis, upon a larger scale than the other figures, and out of its socket.

H. The square protruding part, which fits into the holes of the iron plate.

I. A round part, of the same size and height as the hole in the circle F, (in Fig. 2,) in which it turns.

K. A larger round part, which turns under the circle F, and is by it kept in its place.

## No. 8.

VIEWS *of the* MANUFACTURES *in the* UNITED STATES; *derived from the returns made to the Treasury, pursuant to an Act of Congress, passed May 1st,* 1810. *In a Letter from* S. L. MITCHILL, *to the Hon.* THOMAS NEWTON, *dated Washington, January* 7, 1812.*

DEAR SIR,

THE act further to alter and amend the act providing for the third census or enumeration of the inhabitants of the United States, passed May 1, 1810, made it the duty of the several marshals, secretaries, and their assistants, while they were taking the census of the people, to take also, under the direction of the secretary of the treasury, and according to the instructions he should give, an ac-

* From the American Med. and Philos. Register, vol. 2. p. 405.

count of the several manufacturing establishments and manufactures within their several districts, territories, and divisions. It was directed that the whole of the information so collected should be returned to the secretary of the treasury. It was enacted too that for such additional services, suitable compensation should hereafter be made by law. The money appropriated for counting the inhabitants and registering their manufactures, was one hundred and fifty thousand dollars, which is understood to have been more than enough to defray the whole cost.

Agreeably to the request of the committee of commerce and manufactures, I have paid some attention to the returns made by the marshalls on the state of manufactures in our country. They abound with information; though some of them are executed with greatly more care and exactness than others. Massachusetts appears to have been done with remarkable correctness and method, by counties and towns. The partial accounts are followed by a general recapitulation; and the whole is an example of order and perspicuity exceedingly creditable to Mr. Prince. South Carolina, on the contrary, is an example of carelessness beyond any of the returns. It is deficient in many important respects; and seems to have been sent away in such a hurry, that the columns of figures are not added together into an aggregate sum at the foot.

The information collected in the other states, evinces intermediate degrees of observation and accuracy. Yet it ought to be mentioned of New-Jersey, a state famous for industry and manufactures, that the county abstracts only are forwarded, without any summary whatever of the whole. To render the statement instructive, the reader must bestow the labour of forming the general conclusion; and in attempting this, he will discover fre-

quent instances of incompleteness or inaccuracy. With this may be contrasted the return from Pennsylvania, which evinces an extent of research, on the part of Mr. Smith, honourable to him as an officer, and exhibits the manual arts and trades of the commonwealth to which he belongs, in a highly advantageous light. Their numbers and kinds are displayed with extraordinary detail, both as to the branches carried on and capital employed.

I nevertheless undertook the task of making a general abstract, and of deducing a sort of comprehensive table. I began with the return of Mr. Curtenius, from New-York, and entered the total sums of his several articles in one line upon a sheet of paper. There I recorded the 867 tanneries, 491 distilleries, 42 breweries, 33,068 looms, 467 fulling-mills, 413 carding machines, 26 cotton manufactories, 28 paper-mills, 124 hatteries, 6 glass-houses, 2 powder-mills, 18 rope-walks, 10 refineries of sugar, 28 oil-mills, 11 blast-furnaces, 10 air-furnaces, 44 cut-nail manufactories, and 48 forges, with some other things, particularly the cloths manufactured in that extensive commonwealth. On attempting, however, to arrange the other returns under the same heads, I found great difficulties in the way. For, though Connecticut, North Carolina, Kentucky, and indeed most of the states and territories, corresponded very well to a certain number of titles, yet many of the latter were so difform and various, that it was impossible to class them under corresponding heads.

There were further difficulties. Maine was observed by a different officer from him who took the census of Massachusetts. The return from that district is so unlike the one made by the other marshal, that it is extremely difficult, if not impossible, to make them correspond and harmonize. I despaired, therefore, of effecting a reconcilement in the returns from the two parts of Mas-

sachusetts. Again; Tennessee is in very much the same situation. The marshal of the western district of that state has made a valuable return; his colleague of the eastern district has not equalled him in particularizing and distributing his subject, and besides, has pursued so different a plan that it is not practicable to adapt them.

I might easily make other observations. The return from Rhode-Island might be quoted for its minuteness and accuracy. But, notwithstanding the appearance of observation and fidelity which pervades it, there is almost or quite an impossibility of adjusting its materials with those contained in the other returns. The like remark applies to Ohio, though its return contains indications of perspicacity and intelligence; and to Michigan, whose secretary, Atwater, has furnished a paper which, though small, is a model of perspicuity and neatness.

After several attempts to arrange and methodize the materials, so as to bring them into one compendious view, I became convinced that my labours were fruitless, and abandoned the undertaking. It is certainly a subject of regret that a grand total cannot be formed of all the manufacturing establishments in the nation. Yet we may rejoice that so much has been done. When the next census shall be taken, we may be more successful. An exact schedule of all the subjects of inquiry ought to be formed.* These, if transmitted, to the proper officers, would direct their attention to certain and definite objects. The returns would thereby be rendered uniform, and capable of being added up into one great account, exhibiting in a concordant and uniform manner all the subjects inquired into throughout the states and territories.

Some most valuable information is derived from these returns, incomplete and heterogeneous as they are. Un-

* Not merely formed, at that period, but attended to long before, and even given to the public, that by due deliberation, the most exact and accurate formula may be chosen. Ed.

der the head of sheep, for example, we learn that Vermont contains a stock of 450,000; Massachusetts 399,182; Connecticut 400,000; and Pennsylvania 1,466,918.—Among these are included the individuals of the merino breed, and of the mixed race derived from their communication with the ordinary kind. From these premises we deduce favourable conclusions as to the food derived from their carcasses, the leather from their skins, and above all the clothing from their fleeces.

The number of looms, and of carding and spinning machines, almost exceeds belief, as does also the amount of cloth prepared by the inhabitants. The woollen manufacture has prodigiously increased, as well in the quality and variety, as in the quantity of the goods. Such advances are already made toward supplying domestic fabrics enough to clothe the people, that but few years more will be necessary, under the existing commercial restrictions, to effect that important object.

The progress made in the preparation of cotton-twist, and of the articles into which it may be manufactured by the weaver, has been still more rapid and surprising. From a perusal of these papers, the most comfortable assurance is derived of the amount and fitness of these products of the loom, to afford a covering to man, and furniture for his habitation.

The fabrics of flax are also so far extended, and so much on the increase, as to excite the most cheering prospects of an augmented supply to our citizens, from their own proper labour and skill. The superior excellence of homespun linen is the strongest of all recommendations.

These papers contain a more distinct and interesting exhibition than we ever had before of the saltpetre manufactured in the states. Thus Virginia prepares 59,175 pounds; Kentucky 201,937; Massachusetts 23,600;

East Tennessee 17,531; and West Tennessee, chiefly in Jackson, Warren, White, and Smith counties, 144,895; making nearly half a million pounds of home-made nitre, as good as that usually brought from foreign parts. It is alleged, the quantity may be increased to any desirable amount. The connexion of this with numerous manufactories of gun-powder, puts us quite at our ease as to the nitrate of potash, and to the means we possess of compounding it.

The manufacture of straw is eminently worthy of notice. In Massachusetts, where the forming of bonnets from that material seems to have first begun, the yearly amount of the sales is not less than $ 551,988. The manufacture of straw bonnets has been since undertaken in Connecticut, and produces the yearly value of $ 27,100; and it is worthy of remark, that the labours of two women in New-Jersey, in the same way, yielded them $140, amounting to the sum of $579,228, for the single article of straw bonnets.

Nor is the preparation of sugar from the juice of the maple-tree unimportant. Of this domestic sweet, Ohio produces, in a twelve-month, 3,023,806 pounds; Kentucky, 2,471,647; Vermont, 1,200,000; and East Tennessee, 162,340: making a quantity of nearly seven million pounds in these states only, wherein the returns may be conceived to be greatly within the truth.

Works in horn, ivory, and shell, have made a progress that is worthy of notice. The combs, for instance, which Connecticut prepares annually for market, are estimated at $ 70,000; Massachusetts $ 80,624; and Pennsylvania $ 6,240; equalling a sum of $ 156,864.

I may mention too the abundance of copperas which West Tennessee and Vermont afford. The quantity per annum from the former, is stated at 56,000 lbs.; and from the latter, at 8,000. The quality of these sulphates

of iron is declared to be very fine, and that druggists and dyers may be supplied to any demand they may make.

The tanning of skins is displayed, in these surveys, to great advantage. Indeed, among a people who universally wear shoes of leather, and a great part of whose male inhabitants dress in boots, the consumption of that material is extravagant. By admitting hides and peltry free of impost, and laying heavy duties upon the introduction of tanned and rawed leather, Congress has given ample protection to the operations of preparing skins for use. But our domestic supplies go far beyond the demand for the feet and legs. Saddlery, harness, and books, are principally supplied from the same internal source, to the great extent of their several demands; and the like may be observed of the supplies for the wants of navigation and military equipments.

A prominent feature in the face of this performance is the number of stills employed in the preparation of ardent spirits. The quantity of ardent spirits annually distilled appears, by the returns, to equal the prodigious amount of twenty-three millions seven hundred and twenty thousand gallons. The extraction of brandy from peaches, of an alkoholic liquid from cider, and of whiskey from rye, and even maize, is carried to this alarming excess. These products of the distilleries are chiefly consnmed among ourselves, though a portion of the latter is converted to gin before it reaches the human stomach. While, therefore, we observe the increase of these home-made fluids, we must reflect on their inebriating effects. It cannot be disguised, that their intoxicating quality recommends them to such general employment. Nor ought it to be concealed, that in a country where a gallon of this maddening stimulus can be bought for half a dollar, a gill may be obtained at retail for three cents, and the seller, at the same time, more than double

his money. The fondness for this bewitching beverage, and the repugnance to any excise upon it, raise in the mind a curious association between the free use of it and of political freedom. And it deserves the consideration of all the thinking part of society, how far disease, idleness, immorality, and other mischiefs incidental to strong potation, may not degrade freedom to rudeness and something worse.

A few other important objects disclosed by an examination of these papers, remain to be mentioned.

The number of water and horse-mills employed in spinning cotton, on this exhibition, amounted to 330, in the month of August, 1810, and working one hundred thousand spindles. These, on an average, will spin annually between four and five million pounds of yarn; and that yarn would be sufficient to weave eighteen millions of yards of cotton cloth, three quarters of a yard wide. And this is wholly independent of what may be spun in private families, although it makes part of what is wove there.

The fulling mills returned amount to 1630; and the wool-carding machines, going by water, to 1585.

The number of looms returned exceeds 330,000; and the total number of yards of cloth made of wool, cotton, and flax, as returned, exceeds seventy-five millions.

Gun-powder mills are enumerated to the number of 207. Some of these are, indeed, small; but they count, and, in addition to the larger ones, they prepare yearly 1,450,000 pounds of gun-powder.

Five hundred and thirty furnaces, forges, and bloomeries, are enumerated.

The paper mills amount to 190.

I cannot forbear to express the wish, that these important papers may fall into the hands of some person who may have time and ability to derive from them more extensive information than I am able to give you. But

until this shall be done, the present communication may serve to afford some idea of the manner in which the marshals have executed their instructions, and of the facts which their returns contain.

Allow me to assure you, once more, of my great esteem and regard,*

SAMUEL L. MITCHILL.

No. 9.

[The subject of patents having of late been brought forward in congress, the following remarks &c. may not be irrelevant at this period. The great number of patents annually granted by the United States, renders it proper for every person to be in some measure acquainted with the intention of government in thus securing to every man the reward due to his ingenuity. There can be, however, little doubt, that many of the patents thus obtained, would not be capable of sustaining a just claim for the exclusive privileges acquired; and as the public is really injured under such circumstances, any observations tending to place the business of patents in a proper light, cannot but be useful.]—Ed.†

[Remarks of the Editors of the Retrospect of Philosophical, &c. Discoveries, in relation to Patents, vol. 5. p. 554.]

"The perusal of this specification induces us to advert to the opinion entertained and acted upon by many patentees, namely, that it is only necessary to describe the principle of an invention, without minutely explaining

* It would be very acceptable to the Editor to receive from the different states, complete statistical tables, founded on the returns of the late census. Such communications cannot fail of being in the highest degree interesting, as well as of great importance to all classes of society.

† It is proposed to introduce into the Emporium a list of all the patents which have been granted in Great Britain since the year 1796, in regular succession; and also those which have issued in the United States, by which reference may readily be made to the respective papers in order to check any improper proceedings which may take place on the part of patentees for similar objects.

the construction of the machine founded upon it. As it is the plan and object of this work to afford information on every point connected with patents, for inventions, we deem it consistent with that view to introduce a few remarks, tending to show the fallacy and danger of such an opinion.

The law, permitting to the Crown the privilege of granting patents of monopoly for new inventions, is intended for the public benefit; the reward it offers is held out as an incitement to call genius into exertion for the advantage of the community. Every patentee ought to bear in mind, that the monopoly granted him is the price paid by the public for his discovery, and the patent is made on condition of the public being put in complete possession of it, that is to say, the specification required by the letters patent must be made in such manner, that a competent workman may be enabled to construct a machine capable of performing what the title sets forth, without any invention of his own, and without requiring any further instruction than what the specification affords. As the validity of the patent depends on the correctness of the specification, it behoves the patentee to bestow all his care and ability on this object.

To draw up a specification, which shall contain a luminous and minute description of the machine, without limiting the patentee's privilege to any particular modification of the principles on which it is founded, is a task which requires not only talents and technical knowledge, but great experience in the nature of patent-right; and those who have such an undertaking before them, will do well to avail themselves of any assistance they can procure to contribute to its being ably done; for, provided an invention be original, the patentee's security can be affected by nothing but an injudicious or imperfect specification.

[It is evident that these remarks will apply with equal force to patents of every other nature.]—Ed.

*List of Patents that have been taken out of the office of the Secretary of State, from July,* 1790, *specifying the subject of the Patents, with their dates, and the names of the Patentees.*

1790.

Samuel Hopkins, July 31, making pot and pearl ashes.

Joseph Stacey Sampson, August 6, manufacturing candles.

Oliver Evans, December 18, manufacturing flour and meal.

1791.

Francis Bailey, January 29, punches for types, &c. &c.

Aaron Putnam, January 29, improvement in distilling.

John Stone, March 10, driving piles for bridges.

Samuel Mulliken, March 11, machine for threshing grain and corn.

Samuel Mulliken, March 11, breaking and swingling hemp, &c.

Samuel Mulliken, March 11, machine for cutting and polishing marble, &c.

Samuel Mulliken, March 11, machine for raising a nap on cloths, &c.

George Parkinson, March 17, machine for spinning flax, hemp, &c.

Jonathan Dickerson, July 30, improvement in tide mills.

Samuel Briggs, sen. and jun., August 2, machine for making nails.

William Thomson, August 2, machine for threshing wheat, &c.

Robert R. Livingston, August 4, diminishing the friction of spindles.

John Biddis and Thomas Bedwell, August 10, making the extracts of barks.

Ludwig Conrod Kuhn, August 10, improved bedstead.

Peter Gordon, August 10, manufacturing boots.

Henry Voight, August 10, propelling boats by cattle.

Henry Keyser, August 10, manufacturing gunpowder.

James Macomb, August 26, horizontal water wheels for mills.

James Rumsay, August 26, Improvement of Dr. Barker's mill.

Jamey Rumsey, August 26, improved mode of working mills.

James Rumsey, August 26, Improvement of Savary's steam engine.

James Rumsey, August 26, Bellows.

James Rumsey, August 26, generating steam.

James Rumsey, August 26, Propelling boats or vessels.

John Fitch, August 26, Propelling boats, &c. by steam, &c.

Nathan Read, August 26, Improved boiler of the steam engine.

Nathan Read, August 26, Improvement in distilling.

John Stevens, jun. August 26, Boiler for generating steam.

John Stevens, jun. August 26, Improvement in captain Savary's steam engine.

John Stevens, jun. August 26, application of steam to work bellows.

Englehart Cruse, August 26, Improvement of Savary's steam engine.

Peter Zacharie, November 24, Machine for clearing docks or harbours.

William Pollard, December 30, Machine for spinning cotton.

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*List of English Patents for Inventions, &c.**

William Whitmore, of Birmingham; for an improvement in machines for weighing waggons, &c. Dated January 4, 1796.

Gabriel Wright, of Leadenhall-street; for improvements in azimuth compasses. Dated January 19, 1796.

Jasper Augustus Kelly, of the Strand; for improvements in the construction of harnesses, &c. Dated January 19, 1796.

Edward Thomas Jones, of Bristol; for a new method of keeping accounts. Dated January 26, 1796.

James Stuard, of St. Anne's, Limehouse; for an anchor for ships, &c. Dated February 4, 1796.

Joseph Creswell, of St. George's, Hanover square; for an improved pump. Dated February 4, 1796.

William Paul, of Manchester; for a new machine for printing and staining calicoes, &c. Dated February 4, 1796.

Edward Cook and Richard Eva, of Falmouth; for an apparatus for taking observations and altitudes, &c. Dated February 9, 1796.

William Rudder, of Birmingham; for a method of making metal-cocks, so as to prevent leakage. Dated February 16, 1796.

John Grimshaw, of Strines-Hall, Derbyshire; for the discovery of certain vegetable substances for bleaching, &c. Dated February 17, 1796.

Richard Scantlebury, of Redruth, Cornwall; for a new invented bucket for raising or drawing liquids, &c. Dated February 17, 1796.

* Repert. of Arts, vol. vi. p. 359, &c.

Joseph Hately, of Worcester; for a method of making, from vegetable bodies, a new astringent acid liquid. Dated February 19, 1796.

Felton Matthew, of Three Cranes Wharf, London; for a method of separating the beer from yeast, and preserving the yeast. Dated February 22, 1796.

Henry Clay, of Birmingham, Esq.; for a carriage or machine for the conveyance and shooting of coals, lime, &c. Dated February 27, 1796.

*New Process for refining Sugar.*

A valuable and simple process has lately been discovered by Edward Howard, Esq. F. R. S. for refining sugar, which promises to be of great advantage. The following is an outline of the process, but a more detailed account of it may be expected to be published by that gentleman himself:—" Take brown sugar, sift it through a coarse sieve, then put it lightly into any conical vessel having holes at the bottom (like a coffee machine). Then mix some brown sugar with white syrup, that is, syrup of refined sugar, to the consistency of batter or thick cream, and pour it gently on the top of the sugar in the vessel till the surface is covered. The syrup will soon begin to percolate, and leave the surface in a state which will allow more syrup to be poured upon it, which is to be done carefully. The treacle will be found to come out at the bottom, having left the whole mass perfectly white. The first droppings are to be kept apart, as the last will serve to begin another operation. The sugar is now in a pure state, except as to its containing insoluble matter, which may of course be separated by solution in water.—The clarification is to be performed by the best pipe-clay and fuller's earth, and the addition of neutral alum, if lime be previously contained therein; the whole to be agitated together; and, if expedition be required, it should be heated to the boiling point: the fæculencies will then subside. The brown syrup may also be much improved by means of tannin and the above earths. To make the sugar into snow-white powder, it is only necessary to evaporate the clarified solution to dryness on a water-bath. To make loaves, the common methods may be resorted to, or the syrup drawn off by exhaustion, or small grains may be made according to M. Du Trone's process, *with much water*, and these grains may be cemented by hot concentrated syrup."

*Tilloch*, vol. 30. p. 155. Feb. 1812.

Engrav'd for Emporium of Arts & Sciences.

THE

# EMPORIUM

OF

# ARTS AND SCIENCES.

VOL. 1.] JUNE, 1812. [No. 2.

## No. 10.

### *Tables relating to the three Thermometers commonly used.**

THE thermometers commonly employed, are *Fahrenheit's,* in this country † universally; *Reaumur's* on most parts of the continent; and lately *Celsius's,* or the Swedish thermometer, has been adopted in France under the name of the *Centigrade.* Both the zero and the divisions of each of these three differ. The following three tables will give the correspondences of each thermometer for every degree of each from 212° of Fahr. the boiling point of water, to — 40, the freezing point of mercury.

*Table for Fahrenheit's Thermometer.*

| *Fahr.* | *Reau.* | *Cent.* | *Fahr.* | *Reau.* | *Cent.* | *Fahr.* | *Reau.* | *Cent.* |
|---|---|---|---|---|---|---|---|---|
| 212 | 80.00 | 100.00 | 208 | 78.22 | 97.77 | 204 | 76.44 | 95.55 |
| 211 | 79.55 | 99.44 | 207 | 77.77 | 97.22 | 203 | 76.00 | 95.00 |
| 210 | 79.11 | 98.88 | 206 | 77.33 | 96.66 | 202 | 75.55 | 94.44 |
| 209 | 78.66 | 98.33 | 205 | 76.88 | 96.11 | 201 | 75.11 | 93.88 |

* Aikin's Chemical Dictionary, vol. 2.

† Great Britain; the same Thermometer is that which is employed in the United States. ED.

| Fahr. | Reau. | Cent. | Fahr. | Reau. | Cent. | Fahr. | Reau. | Cent. |
|---|---|---|---|---|---|---|---|---|
| 200 | 74.66 | 93.33 | 151 | 52.88 | 66.11 | 102 | 31.11 | 38.88 |
| 199 | 74.22 | 92.77 | 150 | 52.44 | 65.55 | 101 | 30.66 | 38.33 |
| 198 | 73.77 | 92.22 | 149 | 52.00 | 65.00 | 100 | 30.22 | 37.77 |
| 197 | 73.33 | 91.66 | 148 | 51.55 | 64.44 | 99 | 29.77 | 37.22 |
| 196 | 72.88 | 91.11 | 147 | 51.11 | 63.88 | 98 | 29.33 | 36.66 |
| 195 | 72.44 | 90.55 | 146 | 50.66 | 63.33 | 97 | 28.88 | 36.11 |
| 194 | 72.00 | 90.00 | 145 | 50.22 | 62.77 | 96 | 28.44 | 35.55 |
| 193 | 71.55 | 89.44 | 144 | 49.77 | 62.22 | 95 | 28.00 | 35.00 |
| 192 | 71.11 | 88.88 | 143 | 49.33 | 61.66 | 94 | 27.55 | 34.44 |
| 191 | 70.66 | 88.33 | 142 | 48.88 | 61.11 | 93 | 27.11 | 33.88 |
| 190 | 70.22 | 87.77 | 141 | 48.44 | 60.55 | 92 | 26.66 | 33.33 |
| 189 | 69.77 | 87.22 | 140 | 48.00 | 60.00 | 91 | 26.22 | 32.77 |
| 188 | 69.33 | 86.66 | 139 | 47.55 | 59.44 | 90 | 25.77 | 32.22 |
| 187 | 68.88 | 86.11 | 138 | 47.11 | 58.88 | 89 | 25.33 | 31.66 |
| 186 | 68.44 | 85.55 | 137 | 46.66 | 58.33 | 88 | 24.88 | 31.11 |
| 185 | 68.00 | 85.00 | 136 | 46.22 | 57.77 | 87 | 24.44 | 30.55 |
| 184 | 67.55 | 84.44 | 135 | 45.77 | 57.22 | 86 | 24.00 | 30.00 |
| 183 | 67 11 | 83.88 | 134 | 45.33 | 56.66 | 85 | 23.55 | 29.44 |
| 182 | 66.66 | 83.33 | 133 | 44.88 | 56.11 | 84 | 23.11 | 28.88 |
| 181 | 66.22 | 82.77 | 132 | 44.55 | 55.55 | 83 | 22.66 | 28.33 |
| 180 | 65.77 | 82.22 | 131 | 44.00 | 55.00 | 82 | 22.22 | 27.77 |
| 179 | 65.33 | 81.66 | 130 | 43.55 | 54.44 | 81 | 21.77 | 27.22 |
| 178 | 64.88 | 81.11 | 129 | 43.11 | 53.88 | 80 | 21.33 | 26.66 |
| 177 | 64.44 | 80.55 | 128 | 42.66 | 53.33 | 79 | 20.88 | 26.11 |
| 176 | 64.00 | 80.00 | 127 | 42.22 | 52.77 | 78 | 20.44 | 25.55 |
| 175 | 63.55 | 79.44 | 126 | 41.77 | 52.22 | 77 | 20.00 | 25.00 |
| 174 | 63.11 | 78.88 | 125 | 41.33 | 51.66 | 76 | 19.55 | 24.44 |
| 173 | 62.66 | 78.33 | 124 | 40.88 | 51.11 | 75 | 19.11 | 23.88 |
| 172 | 62.22 | 77.77 | 123 | 40.44 | 50.55 | 74 | 18.66 | 23.33 |
| 171 | 61.77 | 77.22 | 122 | 40.00 | 50.00 | 73 | 18.22 | 22.77 |
| 170 | 61.33 | 76.66 | 121 | 39.55 | 49.44 | 72 | 17.77 | 22.22 |
| 169 | 60.88 | 76.11 | 120 | 39.11 | 48.88 | 71 | 17.33 | 21.66 |
| 168 | 60.44 | 75.55 | 119 | 38.66 | 48.33 | 70 | 16.88 | 21.11 |
| 167 | 60.00 | 75.00 | 118 | 38.22 | 48.77 | 69 | 16.44 | 20.55 |
| 166 | 59.55 | 74.44 | 117 | 37.77 | 47 22 | 68 | 16.00 | 20.00 |
| 165 | 59.11 | 73.88 | 116 | 37.33 | 46.66 | 67 | 15.55 | 19.44 |
| 164 | 58.66 | 73.33 | 115 | 36.88 | 46.11 | 66 | 15.11 | 18.88 |
| 163 | 58.22 | 72.77 | 114 | 36.44 | 45.55 | 65 | 14.66 | 18.33 |
| 162 | 57.77 | 72.22 | 113 | 36.00 | 45.00 | 64 | 14.22 | 17.77 |
| 161 | 57.33 | 71.66 | 112 | 35.55 | 44.44 | 63 | 13.77 | 17.22 |
| 160 | 56.88 | 71.11 | 111 | 35.11 | 43.88 | 62 | 13.33 | 16.66 |
| 159 | 56.44 | 70.55 | 110 | 34.66 | 43.33 | 61 | 12.88 | 16.11 |
| 158 | 56.00 | 70.00 | 109 | 34.22 | 42.77 | 60 | 12.44 | 15.55 |
| 157 | 55.55 | 69.44 | 108 | 33.77 | 42.22 | 59 | 12.00 | 15.00 |
| 156 | 55.11 | 68.88 | 107 | 33.33 | 41.66 | 58 | 11.55 | 14.44 |
| 155 | 54.66 | 68.33 | 106 | 32.88 | 41.11 | 57 | 11.11 | 13.88 |
| 154 | 54.22 | 67.77 | 105 | 32.44 | 40.55 | 56 | 10.66 | 13.33 |
| 153 | 53.77 | 67.22 | 104 | 32.00 | 40.00 | 55 | 10.22 | 12.77 |
| 152 | 53.33 | 66.66 | 103 | 31.55 | 39.44 | 54 | 9.77 | 12.22 |

| *Fahr.* | *Reau.* | *Cent.* | *Fahr.* | *Reau.* | *Cent.* | *Fahr.* | *Reau.* | *Cent.* |
|---|---|---|---|---|---|---|---|---|
| 53 | 9.33 | 11.66 | 21 | -4.88 | -6.11 | -11 | -19.11 | -23.88 |
| 52 | 8.88 | 11.11 | 20 | 5.33 | 6.66 | 12 | 19.55 | 24.44 |
| 51 | 8.44 | 10.55 | 19 | 5.77 | 7 22 | 13 | 20.00 | 25.00 |
| 50 | 8.00 | 10.00 | 18 | 6.22 | 7.77 | 14 | 20.44 | 25.55 |
| 49 | 7.55 | 9.44 | 17 | 6.66 | 8.33 | 15 | 20.88 | 26.11 |
| 48 | 7.11 | 8.88 | 16 | 7.11 | 8.88 | 16 | 21.33 | 26.66 |
| 47 | 6.66 | 8.33 | 15 | 7.55 | 9.44 | 17 | 21.77 | 27.22 |
| 46 | 6.22 | 7.77 | 14 | 8.00 | 10.00 | 18 | 22.22 | 27.77 |
| 45 | 5.77 | 7.22 | 13 | 8.44 | 10.55 | 19 | 22.66 | 28.33 |
| 44 | 5.33 | 6.66 | 12 | 8.88 | 11.11 | 20 | 23.11 | 28.88 |
| 43 | 4.88 | 6.11 | 11 | 9.33 | 11.66 | 21 | 23.55 | 29.44 |
| 42 | 4.44 | 5.55 | 10 | 9.77 | 12.22 | 22 | 24.00 | 30.00 |
| 41 | 4.00 | 5.00 | 9 | 10.22 | 12.77 | 23 | 24.44 | 30.55 |
| 40 | 3.55 | 4.44 | 8 | 10.66 | 13.33 | 24 | 24.88 | 31.11 |
| 39 | 3.11 | 3.88 | 7 | 11.11 | 13.88 | 25 | 25.33 | 31.66 |
| 38 | 2.66 | 3.33 | 6 | 11.55 | 14.44 | 26 | 25.77 | 32.22 |
| 37 | 2.22 | 2.77 | 5 | 12.00 | 15.00 | 27 | 26.22 | 32.77 |
| 36 | 1.77 | 2.22 | 4 | 12.44 | 15.55 | 28 | 26.66 | 33.33 |
| 35 | 1.33 | 1.66 | 3 | 12.88 | 16.11 | 29 | 27.11 | 33.88 |
| 34 | 0 88 | 1.11 | 2 | 13.33 | 16.66 | 30 | 27.55 | 34.44 |
| 33 | 0.44 | 0.55 | 1 | 13.77 | 17.22 | 31 | 28.00 | 35.00 |
| 32 | 0 | 0. | 0 | 14.22 | 17.77 | 32 | 28.44 | 35.55 |
| 31 | -0.44 | -0.55 | -1 | 14.66 | 18.33 | 33 | 28.88 | 36.11 |
| 30 | 0.88 | 1.11 | 2 | 15.11 | 18.88 | 34 | 29.33 | 36.66 |
| 29 | 1.33 | 1.66 |  | 15.55 | 19.44 | 35 | 29.77 | 37.22 |
| 28 | 1.77 | 2.22 | 4 | 16.00 | 20.00 | 36 | 30.22 | 37.77 |
| 27 | 2.22 | 2.77 | 5 | 16.44 | 20.55 | 37 | 30.66 | 38.33 |
| 26 | 2.66 | 3.33 | 6 | 16.88 | 21.11 | 38 | 31.11 | 38.88 |
| 25 | 3.11 | 3.88 | 7 | 17.33 | 21.66 | 39 | 31.55 | 39.44 |
| 24 | 3.55 | 4.44 | 8 | 17.77 | 22.22 | 40 | 32.00 | 40.00 |
| 23 | 4.00 | 5.00 | 9 | 18.22 | 22.77 |  |  |  |
| 22 | 4.44 | 5.55 | 10 | 18.66 | 23.33 |  |  |  |

## *Table for Reaumur's Thermometer.*

| *Rea.* | *Cent.* | *Fahr.* | *Rea.* | *Cent.* | *Fahr.* | *Rea.* | *Cent.* | *Fahr.* |
|---|---|---|---|---|---|---|---|---|
| 80 | 100. | 212. | 70 | 87.5 | 189.5 | 60 | 75. | 167. |
| 79 | 98.75 | 209.75 | 69 | 86.25 | 187.25 | 59 | 73.75 | 164.75 |
| 78 | 97.5 | 207.5 | 68 | 85. | 185. | 58 | 72.5 | 162.5 |
| 77 | 96.25 | 205.25 | 67 | 83.75 | 182.75 | 57 | 71.25 | 160.25 |
| 76 | 95. | 203. | 66 | 82.5 | 180.5 | 56 | 70. | 158. |
| 75 | 93.75 | 200.75 | 65 | 81.25 | 178.25 | 55 | 68.75 | 155.75 |
| 74 | 92.5 | 198.5 | 64 | 80. | 176. | 54 | 67.5 | 153.5 |
| 73 | 91.25 | 196.25 | 63 | 78.75 | 173.75 | 53 | 66.25 | 151.25 |
| 72 | 90. | 194. | 62 | 77.5 | 171.5 | 52 | 65. | 149. |
| 71 | 88.75 | 191.75 | 61 | 76.25 | 169.25 | 51 | 63.75 | 146.75 |

| Rea. | Cent. | Fahr. | Rea. | Cent. | Fahr. | Rea. | Cent. | Fah. |
|---|---|---|---|---|---|---|---|---|
| 50 | 62.5 | 144.5 | 22 | 27·5 | 81.5 | -6 | -7.5 | 18.5 |
| 49 | 61.25 | 142.25 | 21 | 26 25 | 79.25 | 7 | 8.75 | 16.25 |
| 48 | 60. | 140. | 20 | 25. | 77. | 8 | 10. | 14. |
| 47 | 58.75 | 137.75 | 19 | 23.75 | 74.75 | 9 | 11.25 | 11.75 |
| 46 | 57.5 | 135.5 | 18 | 22.5 | 72.5 | 10 | 12.5 | 9.5 |
| 45 | 56.25 | 133.25 | 17 | 21.25 | 70.25 | 11 | 13.75 | 7.25 |
| 44 | 55 | 131. | 16 | 20. | 68. | 12 | 15. | 5. |
| 43 | 53 75 | 128.75 | 15 | 18.75 | 65.75 | 13 | 16.25 | 2.75 |
| 42 | 52.5 | 126.5 | 14 | 17.5 | 63.5 | 14 | 17.5 | 0.5 |
| 41 | 51.25 | 124.25 | 13 | 16.25 | 61.25 | 15 | 18.75 | -1.75 |
| 40 | 50. | 122. | 12 | 15. | 59. | 16 | 20. | 4. |
| 39 | 48.75 | 119.75 | 11 | 13.75 | 56.75 | 17 | 21.25 | 6.25 |
| 38 | 47.5 | 117.5 | 10 | 12.5 | 54.5 | 18 | 22.5 | 8.5 |
| 37 | 46.25 | 115.25 | 9 | 11.25 | 52.25 | 19 | 23.75 | 10 75 |
| 36 | 45. | 113. | 8 | 10. | 50. | 20 | 25. | 13. |
| 35 | 43.75 | 110.75 | 7 | 8.75 | 47.75 | 21 | 26.25 | 15.25 |
| 34 | 42.5 | 108.5 | 6 | 7.5 | 45.5 | 22 | 27.5 | 17.5 |
| 33 | 41.25 | 106.25 | 5 | 6.25 | 43.25 | 23 | 28.75 | 19.75 |
| 32 | 40. | 104. | 4 | 5. | 41. | 24 | 30. | 22. |
| 31 | 38.75 | 101.75 | 3 | 3.75 | 38.75 | 25 | 31.25 | 24.25 |
| 30 | 37.5 | 99.5 | 2 | 2.5 | 36.5 | 26 | 32.5 | 26.5 |
| 29 | 36.25 | 97.25 | 1 | 1.25 | 34.25 | 27 | 33.75 | 28.75 |
| 28 | 35. | 95. | 0 | 0 | 32. | 28 | 35. | 31. |
| 27 | 33.75 | 92 75 | -1 | -1.25 | 29.75 | 29 | 36.25 | 33.25 |
| 26 | 32.5 | 90.5 | 2 | 2.5 | 27.5 | 30 | 37.5 | 35.5 |
| 25 | 31.25 | 88 25 | 3 | 3.75 | 25.25 | 31 | 38.75 | 37.75 |
| 24 | 30. | 86. | 4 | 5. | 23. | 32 | 40. | 40. |
| 23 | 28.75 | 83.75 | 5 | 6.25 | 20.75 | | | |

## Table for the Centigrade Thermometer.

| Cent. | Reau. | Fahr. | Cent. | Reau. | Fahr. | Cent. | Reau. | Fahr. |
|---|---|---|---|---|---|---|---|---|
| 100 | 80. | 212. | 85 | 68. | 185. | 70 | 56. | 158. |
| 99 | 79.2 | 210.2 | 84 | 67.2 | 183.2 | 69 | 55.2 | 156.2 |
| 98 | 78.4 | 208.4 | 83 | 66.4 | 181.4 | 68 | 54.4 | 154.4 |
| 97 | 77.6 | 206.6 | 82 | 65.6 | 179.6 | 67 | 53.6 | 152.6 |
| 96 | 76.8 | 204.8 | 81 | 64.8 | 177.8 | 66 | 52.8 | 150.8 |
| 95 | 76. | 203. | 80 | 64. | 176. | 65 | 52. | 149. |
| 94 | 75.2 | 201.2 | 79 | 63.2 | 174.2 | 64 | 51.2 | 147.2 |
| 93 | 74.4 | 199.4 | 78 | 62.4 | 172.4 | 63 | 50.4 | 145.4 |
| 92 | 73.6 | 197.6 | 77 | 61.6 | 170.6 | 62 | 49.6 | 143.6 |
| 91 | 72.8 | 195.8 | 76 | 60.8 | 168.8 | 61 | 48.8 | 141.8 |
| 90 | 72. | 194. | 75 | 60. | 167. | 60 | 48. | 140. |
| 89 | 71.2 | 192.2 | 74 | 59.2 | 165.2 | 59 | 47.2 | 138.2 |
| 88 | 70.4 | 190.4 | 73 | 58.4 | 163.4 | 58 | 46.4 | 136.4 |
| 87 | 69.6 | 188.6 | 72 | 57.6 | 161.6 | 57 | 45.6 | 134.6 |
| 86 | 68.8 | 186.8 | 71 | 56.8 | 159.8 | 56 | 44.8 | 132.8 |

| *Cent.* | *Reau.* | *Fahr.* | *Cent.* | *Reau.* | *Fahr.* | *Cent.* | *Reau.* | *Fahr.* |
|---|---|---|---|---|---|---|---|---|
| 55 | 44. | 131. | 23 | 18.4 | 73.4 | −9 | −7.2 | 15.8 |
| 54 | 43.2 | 129.2 | 22 | 17.6 | 71.6 | 10 | 8. | 14. |
| 53 | 42.4 | 127.4 | 21 | 16.8 | 69.8 | 11 | 8.8 | 12.2 |
| 52 | 41.6 | 125.6 | 20 | 16 | 68. | 12 | 9.6 | 10.4 |
| 51 | 40.8 | 123.8 | 19 | 15.2 | 66.2 | 13 | 10.4 | 8.6 |
| 50 | 40. | 122. | 18 | 14.4 | 64.4 | 14 | 11.2 | 6.8 |
| 49 | 39.2 | 120.2 | 17 | 13.6 | 62.6 | 15 | 12. | 5. |
| 48 | 38.4 | 118.4 | 16 | 12.8 | 60.8 | 16 | 12.8 | 3.2 |
| 47 | 37.6 | 116.6 | 15 | 12. | 59. | 17 | 13.6 | 1.4 |
| 46 | 36.8 | 114.8 | 14 | 11.2 | 57.2 | 18 | 14.4 | −0.4 |
| 45 | 36. | 113. | 13 | 10.4 | 55.4 | 19 | 15.2 | 2.2 |
| 44 | 35.2 | 111.2 | 12 | 9.6 | 53.6 | 20 | 16. | 4. |
| 43 | 34.4 | 109.4 | 11 | 8.8 | 51.8 | 21 | 16.8 | 5.8 |
| 42 | 33.6 | 107.6 | 10 | 8. | 50. | 22 | 17.6 | 7.6 |
| 41 | 32.8 | 105.8 | 9 | 7.2 | 48.2 | 23 | 18.4 | 9.4 |
| 40 | 32. | 104. | 8 | 6.4 | 46.4 | 24 | 19.2 | 11.2 |
| 39 | 31.2 | 102.2 | 7 | 5.6 | 44.6 | 25 | 20. | 13. |
| 38 | 30.4 | 100.4 | 6 | 4.8 | 42.8 | 26 | 20.8 | 14.8 |
| 37 | 29.6 | 98.6 | 5 | 4. | 41. | 27 | 21.6 | 16.6 |
| 36 | 28.8 | 96.8 | 4 | 3.2 | 39.2 | 28 | 22.4 | 18.4 |
| 35 | 28. | 95 | 3 | 2.4 | 37.4 | 29 | 23.2 | 20.2 |
| 34 | 27.2 | 93.2 | 2 | 1.6 | 35.6 | 30 | 24. | 22. |
| 33 | 26.4 | 91.4 | 1 | 0.8 | 33.8 | 31 | 24.8 | 23.8 |
| 32 | 25.6 | 89.6 | 0 | 0. | 32. | 32 | 25.6 | 25.6 |
| 31 | 24.8 | 87.8 | −1 | −0.8 | 30.2 | 33 | 26.4 | 27.4 |
| 30 | 24. | 86. | 2 | 1.6 | 28.4 | 34 | 27.2 | 29.2 |
| 29 | 23.2 | 84.2 | 3 | 2.4 | 26.6 | 35 | 28. | 31. |
| 28 | 22.4 | 82.4 | 4 | 3.2 | 24.8 | 36 | 28.8 | 32.8 |
| 27 | 21.6 | 80.6 | 5 | 4. | 23. | 37 | 29.6 | 34.6 |
| 26 | 20.8 | 78.8 | 6 | 4.8 | 21.2 | 38 | 30.4 | 36.4 |
| 25 | 20. | 77. | 7 | 5.6 | 19.4 | 39 | 31.2 | 38.2 |
| 24 | 19.2 | 75.2 | 8 | 6.4 | 17.6 | 40 | 32. | 40. |

## *Tables for reducing the Degrees of Beaume's Areometer into their corresponding expression of Specific Gravity.*

Beaume's Areometer or Hydrometer, though not a very correct instrument, is that which from its convenience is employed very commonly by the French chemists, who are in the habit of expressing the strength or specific gravity of the acids, alcohol, &c. which they employ by the

scale of this instrument. It is described by Beaumé in his Elemens de Pharmacie, p. 466.

The form of this instrument is that of the common hydrometer, that is, a lengthened bulb or ball with a long narrow stem rising from it, which last is graduated, and the instrument is so poised that it floats with nearly the whole of the stem above the level of the heaviest liquid whose density it is to indicate, and with nearly the whole of the stem immersed when the lightest liquid is used. A single instrument would in strictness suffice to indicate the density of every liquid from the lightest alcohol to the heaviest acid, which would include a range of actual specific gravity from about .8 to 2. (water being = 1.) But an instrument of this kind must be either inconveniently long, or the stem must be very wide, and the degrees too minute for tolerable accuracy. Beaumé therefore very judiciously divided it into two scales, one of which is the areometer for spirits and liquors lighter than water, and the other the areometer for salts or liquids heavier than water. He has further distinguished them by inverting the scales, that is to say, in the instrument for salts the 0. or zero is at distilled water, and the numbers increase with the *increasing* density of the liquors for which it is used; whereas in the instrument for spirits the numbers increase from the zero with the *decreasing* density. Hence it is necessary to describe these two instruments separately.

The hydrometer for salts was made by Beaumé in the following way: the instrument was first immersed in water at 18.75° Reaum. = about 50° Fahr. and loaded with mercury dropped into the bulb till it sunk so low that only the very top of the stem was out of water, which point was marked as the 0. of the scale. The instrument was then removed to a solution of common salt, containing 15 parts (by weight) of salt to 85 parts of wa-

ter, and the height to which it floated was marked on the stem as 15° of the scale. The interval between these two points of immersion being therefore considered as 15 degrees, the scale was extended to any required number, merely by marking off with compasses an equal length of the stem, and the whole was farther subdivided in the same way. Beaumé considered therefore that every degree of the instrument indicated a density of liquid equal to that of a solution of common salt, in which the number of parts of salt in 100 parts, by weight, of the solution, was equal to the same number on the scale at which the instrument floated. But as the diameter of the stem is seldom equal throughout, he proposes to remedy the incorrectness produced by this circumstance, where greater accuracy is required, by immersing the instrument successively in solutions containing 5, 10, 15, &c. per cent. of salt, and marking these points as 5, 10, 15, &c. on the scale, or, to be still more accurate, all the individual degrees may be found by actual experiment. In fact, even where the stem of the instrument is perfectly cylindrical, this would be the only way to ensure perfect accuracy, as a division of equal distances on the scale would not precisely correspond with an equal increase of percentage of salt in the solution.

The scale of this instrument does not properly extend higher than about 30°, as this is the point of saturation of water with salt, but it may be lengthened at pleasure by marking off equal distances on the scale.

The following table of correspondence between Beaumé's areometer for salts and the actual expression of specific gravity has been calculated by Mr. Nicholson, for every third degree (Phil. Journ. 4to. vol. i. p. 38.) from the datum of Morveau that the 66th degree corresponds with 1.848 sp. gr. We have added to it the specific gravities of most of the corresponding solutions of com-

mon salt in water as high as 30° of the instrument, as given by Hassenfratz in the 28th vol. of the An. de Chim. p. 298, which ought therefore to be the same, but which actually differ in no inconsiderable degree.

We have further added the corresponding specific gravities with many of the degrees of the hydrometer from 18° to 45°, as given by R. Bingley, Esq. King's Assay-Master of the Mint, (Philosophical Magazine, vol. xii.) from actual experiments with a Paris hydrometer. This includes a specific gravity from 1.150 to 1.435, which, with acids, is sufficient for most of the purposes of the assayer or mineralogist.

*Beaume's Hydrometer for Salts.* (Temperature 55° Fahr.)

| *Beaumé.* | *Nicholson.* | *Hassenfratz.* | *Bingley.* |
|---|---|---|---|
| 1=Sp. Gr. | 1.000= | 1.0000= | |
| 2 | | 1.0128 | |
| 3 | 1.020 | 1.0192 | |
| 4 | | 1.0256 | |
| 5 | | 1·0320 | |
| 6 | 1.040 | 1.0384 | |
| 7 | | 1.0448 | |
| 8 | | 1.0502 | |
| 9 | 1.064 | 1.0576 | |
| 10 | | 1.0640 | |
| 12 | 1.089 | 1.0775 | |
| 14 | | 1.0910 | |
| 15 | 1.114 | | |
| 16 | | 1.1045 | |
| 18 | 1.140 | 1.1182 | 1.150 |
| 20 | | 1.1320 | 1.167 |
| 21 | 1.170 | | |
| 22 | | 1.1462 | |
| 24 | 1.200 | 1.1608 | |
| 26 | | 1.1760 | 1.216 |
| 27 | 1.230 | | |
| 28 | | 1.1920 | 1.233 |
| 29 | | | 1.250 |
| 30 | 1 261 | 1.2100 | 1.267 |

| *Beaumé.* | *Nicholson.* | *Bingley.* |
|---|---|---|
| 31=Sp. Gr. | | 1.275 |
| 32 | | 1.283 |
| 33 | 1.295 | |
| 34 | | 1.300 |
| 35 | | 1.312 |
| 36 | 1.333 | 1.313 |
| 37 | | 1.342 |
| 38 | | 1.350 |
| 39 | 1.373 | 1.358 |
| 40 | | 1.367 |
| 41 | | 1.383 |
| 42 | 1.414 | 1.400 |
| 43 | | 1.416 |
| 45 | 1.455 | 1.435 |
| 48 | 1.500 | |
| 51 | 1.547 | |
| 54 | 1.597 | |
| 57 | 1.659 | |
| 60 | 1.717 | |
| 63 | 1.779 | |
| 66 | 1.848 | |
| 69 | 1.920 | |
| 72 | 2.000 | |

The Hydrometer for Spirits is constructed exactly on the same principle, and the mode of graduation is also the same, that is, by a solution of salt, and not by mix-

tures of alcohol and water of different densities. In this hydrometer the zero is placed not at the point to which the stem sinks in distilled water, but at the point to which it falls in a mixture of 10 parts of salt and 90 of water. The interval between this point and that of distilled water is marked on the scale as 10 degrees, and this scale is continued upwards on the stem simply by measuring equal portions by the compasses. The 10th degree of the spirit hydrometer corresponds with the 0. of the salt hydrometer, and it is certainly a defect that the ingenious inventor should have introduced this deviation from what is obviously the natural zero in each scale, namely, the point of immersion in distilled water; since it was as easy to obtain a measure for 10 degrees of the scale of the spirit hydrometer by beginning the notation 10 degrees below zero as at this point.

The correspondence between Beaumé's spirit hydrometer and the real expression of specific gravity has also been calculated by Mr. Nicholson, and on the following data: viz. Beaumé found that a spirit of .842 sp. gr. at 32° Fahr. gave 37 degrees of his hydrometer; and that a mixture of two parts, by weight, of this spirit with 30 of water gave 12 degrees of the hydrometer at the same temperature.

This mixture is found by Gilpin's valuable tables to be = .9915 specific gravity at this temperature, and these terms, viz. .842 and .9915 become .832 and .9905 at 55° Fahr. or 10° Reaum. the standard temperature of the graduation of these instruments. We have given in the article ALCOHOL, p. 30, Vol. 1,* of this work, Beaumé's table of the density of different mixtures of alcohol and water expressed in the degrees of his hydrometer, with the corresponding specific gravities as given by

* Of Aikin's Dictionary. ED.

Hassenfratz (An. Chim. tom. xxxiii. p. 11.) we shall here repeat the latter as a comparison with those given by Mr. Nicholson, and which will further shew the degree of incorrectness of Beaumé's instrument.

*Beaume's Hydrometer for Spirits.* (Temperature 55° F.)

| *Beaumé.* | *Nicholson.* | *Hassenfratz.* | *Beaumé.* | *Nicholson.* | *Hassenfratz.* |
|---|---|---|---|---|---|
| 10 = | 1.0000 = | 1.0000 | 25 = | .897 = | .9057 |
| 11 = | .990 = | | 26 = | .892 = | |
| 12 = | .985 = | .9863 | 27 = | .886 = | 0.8944 |
| 13 = | .977 = | .9796 | 28 = | .880 = | |
| 14 = | .970 = | .9730 | 29 = | .874 = | |
| 15 = | .963 = | .9666 | 29½ = | = | .8807 |
| 16 = | .955 = | . | 30 = | .871 = | |
| 16½ = | = | .9569 | 31 = | .867 = | |
| 17 = | .949 = | | 32 = | .856 = | .8675 |
| 18 = | .942 = | .9474 | 33 = | .852 = | |
| 19 = | .935 = | . | 34 = | .847 = | .8571 |
| 19½ = | = | .9382 | 35 = | .842 = | |
| 20 = | .928 = | | 36 = | .837 = | |
| 21 = | .922 = | .9290 | 37 = | .832 = | .8421 |
| 22 = | .915 = | | 38 = | .827 = | |
| 23 = | .909 = | .9172 | 39 = | .822 = | |
| 24 = | .903 = | | 40 = | .817 = | .8276 |

## No. 11.

## ON SPONTANEOUS COMBUSTION.

(Continued from page 64.)

### *Account of a spontaneous Inflammation, which happened at Spalding, in Lincolnshire.**

In the latter end of July, 1794, a bale of candle-wick yarn, made from hemp, in imitation of cotton yarn, was brought to Spalding, from Birmingham; it came by inland navigation to the Trent, was shipped at Gainsborough for Boston, and unloaded there into a Spalding

* Repert. of Arts and Manufactures, vol.3. p.19.

lighter; so that it could not have been less than a month upon its passage.

When examined, it was found to be so much soaked with oil, resembling in smell rape-oil, that, instead of 120 lb. the net weight of the yarn, it weighed 150 lb. or thereabouts; but no probable *guess* * could be made of the time when the accident, by which the oil had fallen upon it, happened.

It was placed in a warehouse at Spalding, where it remained about three weeks; during the whole of which time, a journeyman of the shop it belonged to, and an apprentice, passed every night close to it in their way to bed, but they never observed any smell issuing from it, though they once, during the latter part of the time, assisted in removing it to some distance from the place in which it had stood.

On Saturday, the 16th of August, the day after it had been removed, a smell of fire was observed in the house, but it does not seem probable that this smell issued from the bale, as the journeyman and apprentice passed it at night as usual, and on the next night also; when, on account of the day being Sunday, the warehouse had remained shut the whole day without any unusual smell being observed, though on Sunday night the journeyman accidentally stumbled upon it.

At three o'clock the next morning, however, both were

* This is I believe a word which the English consider as characteristic of the American phraseology, and which has consequently been the subject of their ill timed ridicule. They will however now scarcely dispute its propriety, since it is employed, not only by the present author, but by one of their countrymen who is regarded amongst the chastest writers of their language; I mean the celebrated Sir William Jones.—See Asiatic Researches, vol. 1. p. 4. Eng. edit. 4to.—If we may use a vulgar expression, we may say, "An Englishman may steal a horse, whilst an Irishman dare not look over the hedge." After the severe, but well merited remarks on this subject, which lately appeared in the Port Folio, it is to be hoped the English will admit their language to be employed with as much propriety in America, as amongst themselves. Ed.

awakened by a smoke of a very suffocating smell; they immediately rose, and instantly saw, on opening the warehouse-door, that the bale was on fire, and glowing; fortunately the warehouse was above-stairs, and the bale lay near the door by which goods are taken in, so that it was easily thrust out into the street, where it instantly blazed with such fury as to damage the paint over the door of the house near which it lay; it would probably have set fire to the wood-work had not water been at hand, with which it was quenched, when four stone only of the yarn were consumed.

## No. 12.

### *Account of a Spontaneous Inflammation, which happened in India; by* Isaac Humfries, Esq.*

On going into the arsenal a few mornings since, I found my friend Mr. Golding, the commissary of stores, under the greatest uneasiness, in consequence of an accident which had happened the preceding night. A bottle of linseed-oil had been left on a table, close to which a chest stood which contained some coarse cotton cloth; in the course of the night the bottle of oil was thrown down, and broken on the chest, (by rats most probably,) and part of the oil ran into the chest, and on the cloth. When the chest was opened in the morning, the cloth was found in a very strong degree of heat, and partly reduced to tinder, and the wood of the box discoloured, as from burning. After a most minute examination, no appearance of any other inflammable substance could be

* Repert. of Arts and Manufactures, vol. 3. p. 21. From the Trans. of the Roy. Soc. Lond.

found, and how the cloth could have been reduced to the condition in which it was found, no one could even conjecture. The idea which occurred, and which made Mr. Golding so uneasy, was that of an attempt to burn the arsenal. Thus matters were when I joined him, and when he told me the story, and shewed me the remainder of the cloth. It luckily happened that, in some chemical amusements, I had occasion to consult Hopson's Chemistry a very few days before, and met with a passage on this particular subject, (p. 629,) which I read with a determination to pursue the experiment at some future period, but had neglected to do so. The moment I saw the cloth, the similarity of circumstances struck me so forcibly, that I sent for the book, and shewed it to Mr. Golding, who agreed with me that it appeared sufficient to account for the accident; however, to convince ourselves, we took a piece of the same kind of cloth, wetted it with linseed-oil, and put it into a box, which was locked and carried to his quarters. In about three hours the box began to smoke, when, on opening it, the cloth was found exactly in the same condition as that which had given us so much uneasiness in the morning; and, on opening the cloth, and admitting the external air, it burst into fire. This was sufficiently convincing; however, to make it more certain, the experiment was three times tried, and with the same success.

## No. 13.

*Observations on Spontaneous Inflammations; with a particular Account of that which happened on board a Russian Frigate in the year* 1781; *and of the Experiments made in order to ascertain the cause of it. In a Letter to the Editors, from the Reverend* William Tooke, *F. R. S. Member of the Imperial Academy of Sciences at St. Petersburgh, &c.**

The following observations on spontaneous inflammations were drawn up, a few years ago, in Russia; they were suggested by an accident which happened on board a frigate lying in the harbour of Cronstadt, of which mention is made in your last number.† I was then at Cronstadt, and consequently had an opportunity of procuring an accurate account, not only of the accident itself, but also of the experiments made to ascertain the cause of it. If you think proper to add them to the accounts of spontaneous inflammations which you have already published, you are at liberty to do so.

The explication of the causes of spontaneous inflammations, in certain substances and compositions, must ever be an object of consequence to the magistracy; as, by discovering the causes of such phænomena, the suspicion of felonious practices in setting fire to buildings may frequently be avoided, and many an innocent person saved from capital punishment. A bare attempt to lessen the number of victims, that may possibly be doomed to bleed at the bar of mistaken justice, can never be thought either frivolous or impertinent.

I intentionally pass over the *pyrophori*, at present so well known to chymists, prepared from alum, &c. as not

* Repert. of Arts and Manufactures, vol. 3. p. 95. † See p. 60.

properly belonging to my design, though deserving of notice in explaining the causes of spontaneous inflammation; nor shall I say any thing of those inflammations that happen in the mineral kingdom, in coal-mines, alum-pits, &c. as they are sufficiently known, and their causes have often been discussed.

Of incomparably more importance, and far less known, are the spontaneous inflammations of substances from the animal and vegetable kingdoms; and these are what I design here briefly to bring together; as I firmly believe, that a more extensive publication of these phænomena may prove of general utility to mankind, by lessening the dangers to which they are exposed.

A recent instance will serve to elucidate what I now advance. A person of the name of Rüde, at that time an apothecary at Bautzen, had prepared a *pyrophorus* from rye-bran and alum. Not long after he had made the discovery, there broke out, in the village of Naussitz, a great fire, which did much mischief, and was said to have been occasioned by the treating of a sick cow in the cow-house. Mr. Rüde knew that the countrymen were used to lay an application of parched rye-bran to their cattle, for curing the thick neck; he knew also, that alum and rye-bran, by a proper process, yielded a *pyrophorus;* and now he wished to try whether parched rye-bran alone would have the same effect. Accordingly, he roasted a quantity of rye-bran by the fire, till it had acquired the colour of roasted coffee. This roasted bran he wrapped up in a linen cloth; in the space of a few minutes there arose a strong smoke through the cloth, accompanied by a smell of burning. Not long afterwards the rag grew as black as tinder, and the bran, now become hot, fell through it on the ground in little balls. Mr. Rüde repeated the experiment at various times, and always with the same result. Who now will

any longer doubt, that the frequency of fires in cow-houses, which, in those parts, are mostly wooden buildings, may not be occasioned by this common practice, of binding roasted bran about the necks of the cattle? The fire, after consuming the cattle and the shed, communicates itself to the adjoining buildings; great damage ensues; and the ignorant look for the cause in wilful and malicious firing, consequently in a capital crime.

Montet relates, in the *Mémoires de l'Académie de Paris*, 1748, that animal substances, under certain circumstances, may kindle into flame; and that he himself has been witness to the spontaneous accension of dung-hills. The woollen stuff prepared at Sevennes, which bears the name of Emperor's-stuff, has kindled of itself, and burnt to a coal. It is not unusual for this to happen to woollen stuffs, when in hot summers they are laid in a heap, in a room but little aired.

In June, 1781, the same thing happened at a wool-comber's, in a manufacturing town in Germany, where a heap of wool-combings, piled up in a close warehouse seldom aired, took fire of itself. This wool had been by little and little brought into the warehouse; and, for want of room, piled up very high, and trodden down, that more might be added to it. That this combed wool, to which, as is well known, rape-oil mixed with butter is used in the combing, burnt of itself, was sworn by several witnesses. One of them affirmed that, ten years before, a similar fire happened among the flocks of wool at a clothier's, who had put them into a cask, where they were rammed hard, for their easier conveyance. This wool burnt from within outwards, and became quite a coal; it was very certain that neither fire nor light had been used at the packing, consequently the above fires arose from similar causes.

In like manner very credible cloth-workers have cer-

tified, that after they have bought wool that was become wet, and packed it close in their warehouse, this wool has burnt of itself; and very serious consequences might have followed, if it had not been discovered in time.

The spontaneous accension of various matters from the vegetable kingdom, as wet hay, corn, and madder, and at times wet meal and malt, are already sufficiently known. Experiments have likewise repeatedly been made with regard to such phænomena; and it will presently appear, that hemp, or flax, and hemp-oil, have frequently given rise to dreadful conflagrations. Montet says: In the year 1757, a sort of sail-cloth, called *prelart,* having one side of it smeared with ochre and oil, took fire in the magazine at Brest, where it had probably kindled of itself. It is not at all unlikely that many fires in sea-ports have arisen from these self-accensions; as it has often happened that, after the strictest inquiry, the real cause of them has not been discovered.

About twenty years ago, several fires broke out within a short space of time in a rope-walk, and in some wooden houses, at St. Petersburgh; and, in all these instances, not the slightest trace of wilful firing could be found: but there was lying in the rope-walk, where the cables for the navy are made, a great heap of hemp, among which a considerable quantity of oil had been carelessly spilt, and it was therefore declared spoilt; for which reason it had been bought at a low price, and put up together, and was held to be the cause of the fire. The inferior inhabitants of that part of the town had likewise bought of this spoilt hemp, at a cheaper rate than usual, for closing the chinks, and caulking the windows of their houses, which are constructed of balks laid one upon the other. At this rope-walk, coils of cable have been found hot, and the people have been obliged to separate them, to prevent farther danger.

It was in the spring of the year 1780, that a fire was discovered on board a frigate lying in the road off Cronstadt; which, if it had not been timely extinguished, would have endangered the whole fleet. After the severest scrutiny, no cause of the fire was to be found; and the matter was forced to remain without explanation, but with strong surmises of some wicked incendiary being at the bottom of it. In the month of August, in the same year, a fire broke out at the hemp-magazine at St. Petersburgh, by which several hundred thousand poods * of hemp and flax were consumed. The walls of the magazine are of brick, the floors of stone, and the rafters and covering of iron; it stands alone on an island in the Neva, on which, as well as on board the ships lying in the Neva, no fire is permitted. In St. Petersburgh, in the same year, a fire was discovered in the vaulted shop of a furrier. In these shops, which are all vaults, neither fire nor candle is allowed, and the doors of them are all of iron. At length the probable cause was found to be, that the furrier, the evening before the fire, had got a roll of new cere-cloth, (much in use here for covering tables, counters, &c. being easily wiped and kept clean,) and had left it in his vault, where it was found almost consumed.

In the night between the 20th and 21st of April, 1781, a fire was seen on board the frigate Maria, which lay at anchor, with several other ships, in the road off the island of Cronstadt; the fire was however soon extinguished; and, by the severest examination, little or nothing could be extorted concerning the manner in which it had arisen. The garrison was threatened with a scrutiny that should cost them dear; and, while they were in this cruel suspense, the wisdom of the sovereign gave a turn to

* A pood consists of 40 pounds Russ, or 36 pounds English.

the affair, which quieted the minds of all, by pointing out the proper method to be pursued by the commissioners of inquiry, in the following order to Count Chernichef.

" When we perceived, by the report you have deli-
" vered in of the examination into the accident that hap-
" pened on board the frigate Maria, that, in the cabin
" where the fire broke out, there were found parcels of
" matting, tied together with packthread, in which the
" soot of burnt fir-wood had been mixed with oil, for the
" purpose of painting the ship's bottom, it came into our
" mind, that, at the fire which happened last year at the
" hemp-warehouses, the following cause, among others,
" was assigned, that the fire might have proceeded from
" the hemp being bound up in greasy mats, or even from
" such mats having lain near the hemp: therefore, ne-
" glect not to guide your farther inquiries by this re-
" mark."

As, upon juridical examination, as well as private inquiry, it was found that, in the ship's cabin, where the smoke appeared, there lay a bundle of matting, containing Russian lamp-black, prepared from fir-soot, moistened with hemp-oil varnish, which was perceived to have sparks of fire in it at the time of the extinction, the Russian admiralty gave orders to make various experiments, in order to see whether a mixture of hemp-oil varnish and the forementioned Russian black, folded up in a mat and bound together, would kindle of itself.

They shook forty pounds of fir-wood soot into a tub, and poured about thirty-five pounds of hemp-oil varnish upon it; this they let stand for an hour, after which they poured off the oil. The remaining mixture they now wrapped up in a mat, and the bundle was laid close to the cabin, where the midshipmen had their birth. To avoid all suspicion of treachery, two officers sealed both

the mat and the door with their own seals, and stationed a watch, of four sea-officers, to take notice of all that passed the whole night through; and, as soon as any smoke should appear, immediately to give information to the commandant of the port.

The experiment was made the 26th of April, about 11 o'clock A. M. in presence of all the officers named in the commission. Early on the following day, about 6 o'clock A. M. a smoke appeared, of which the chief commandant was immediately informed by an officer; he came with all possible speed, and, through a small hole in the door, saw the mat smoking. Without opening the door, he dispatched a messenger to the members of the commission; but, as the smoke became stronger, and fire began to appear, the chief commandant found it necessary, without waiting for the members of the commission, to break the seals and open the door. No sooner was the air thus admitted, than the mat began to burn with greater force, and presently it burst into a flame.

The Russian Admiralty, being now fully convinced of the self-enkindling property of this composition, transmitted their experiment to the Imperial Academy of Sciences; who appointed my friend Mr. Georgi, a very learned and able adjunct of the Academy, to make farther experiments on the subject, and to him I am chiefly indebted for this account; though, being myself at the time upon a visit to some of my old parishioners at Cronstadt, I made myself acquainted with many of the circumstances on the spot.

The experiments of this ingenious chemist are of great importance, as they form a valuable addition to our knowledge on the subject; and are very remarkable from the occasion that led to these discoveries.

Previous to the relation of the experiments, it is necessary to observe, that the Russian fir-black is three or four

times more heavy, thick, and unctuous, than that kind of painter's black which the Germans call *kien-rahm.* The former is gathered at Ochta, near St. Petersburgh, at Mosco, at Archangel, and other places, in little wooden huts, from resinous fir-wood, and the unctuous bark of birch, by means of an apparatus uncommonly simple, consisting of pots without bottoms set one upon the other; and is sold very cheap. The famous fine German *kien-rahm* is called in Russia *Holland's black.* In what follows, when I speak of raw oil, it is to be understood of linseed-oil or hemp-oil; but most commonly the latter. The varnish is made of five pounds of hemp-oil boiled with two ounces and a half of minium. For wrapping up the composition, Mr. Georgi made use of coarse hemp-linen, and always single, never double. The impregnations and commixtures were made in a large wooden bowl, in which they stood open till they were wrapt up in linen.

That I may not be too prolix, I will select and communicate only such of the experiments as were most remarkable, and succeeded best.

Three pounds of Russian fir-black were slowly impregnated with five pounds of hemp-oil-varnish; and, when the mixture had stood open five hours, it was bound up in linen. By this process it became clotted; but some of the black remained dry. When the bundle had lain sixteen hours in a chest, it was observed to emit a very nauseous, and rather putrid, smell, not quite unlike that of boiling oil. Some parts of it became warm, and steamed much; this steam was watery, and by no means inflammable. Eighteen hours after the mixture was wrapt up, one place became brown, emitted smoke, and directly afterwards glowing fire appeared. The same thing happened in a second and a third place; though other places were scarcely warm. The fire crept slowly around, and

gave a thick, grey, stinking smoke. Mr. Georgi took the bundle out of the chest, and laid it on a stone pavement; when, on being exposed to the free air, there arose a slow burning flame, a span high, with a strong body of smoke. Not long afterwards there appeared, here and there, several chaps, or clefts, as from a little volcano, the vapour issuing from which burst into flame. On his breaking the lump, it burst into a very violent flame, full three feet high, which soon grew less, and then went out. The smoking and glowing fire lasted for the space of six hours; and afterwards the remainder continued to glow without smoke for two hours longer. The grey earthy ashes, when cold, weighed about five ounces and a half.

In another experiment, perfectly similar to the foregoing, as far as relates to the composition and quantities, the enkindling did not ensue till forty-one hours after the impregnation: the heat kept increasing for three hours, and then the accension followed.

It is worthy of remark, that these experiments succeeded better on bright days than on such as were rainy; and the accension came on more rapidly.

In another experiment, three pounds of Russian fir-black were slowly impregnated with three pounds of raw hemp-oil; and the accension ensued after nine hours.

Three quarters of a pound of German *rahm* were slowly impregnated with a pound and a half of hemp-oil varnish. The mixture remained seventy hours before it became hot and reeking. It then gradually became hotter, and emitted a strong exhalation; the effluvia were moist, and not inflammable. The re-action lasted thirty-six hours, during which the heat was one while stronger, and then weaker, and at length quite ceased.

Stove or chimney soot, mostly formed from birch-wood smoke, was mingled with the above-mentioned sub-

stances and tied up; the compound remained cold and quiet.

Russian fir-black, mixed with equal parts of oil of turpentine, aud bound up, exhibited not the least re-action or warmth.

Birch-oil, mixed with equal parts of Russian fir-black, and bound up, began to grow warm and to emit a volatile smell; but the warmth soon went off again.

From the experiments of the Admiralty, and of Mr. Georgi, we learn, not only the decisive certainty of the self-accension of soot and oil, when the two substances are mixed under certain circumstances, but also the following particulars.

Of the various kinds of soot, or lamp-black, the experiments succeeded more frequently and surely with the coarser, more unctuous, and heavier, like Russian painter's black, than with fine light German *rahm,* or with coarse chimney-soot. In regard to oils, only those experiments succeeded which were made with drying oils, either raw or boiled. The proportions of the soots to the oils were, in the successful experiments, very various; the mixture kindled with a tenth, a fifth, a third, with an equal, and likewise with a double, proportion of oil. In general, however, much more depends on the mode of mixture, and the manipulation; and, as Mr. Georgi often observed, on the weather: for, in moist weather, the bundles, after becoming warm, would frequently grow cold again.

It is in all respects remarkable, that it should never till now have been observed, that a mixture which has been made millions of times, in all proportions and quantities, for painting of ships, and the outsides of wooden houses, and sometimes intentionally, sometimes accidentally, left covered or open, a longer or a shorter time, should be capable of kindling of itself. It is highly pro-

bable, that, even on this occasion, it was entirely owing to the attention of the Empress that it was made an object of inquiry, or even that it was at all observed.

Before I finish this paper, I will just mention a self-accension, not noticed till of late, and that by Mr. Hagemann, an apothecary at Bremen. He prepared a boiled oil of *hyoscyamus*, or henbane, in the usual way, with common oil. The humidity of the herb was nearly evaporated, when he was called away by other affairs, and was obliged to leave the oil on the fire. The evaporation of the humidity was hereby carried so far, that the herb could easily be rubbed to powder. The oil had lost its green colour, and had become brownish. In this state it was laid on the straining-cloth, and placed in the garden, behind the house, in the open air.

In the space of half an hour, on coming again to this place, he perceived a strong smoke there, though he thought the oil must long have been cooled: on closer inspection, he found that the smoke did not proceed from the oil, but from the herb on the straining-cloth; at the the same time the smell betrayed a concealed fire.

He stirred the herb about, and blew into it with a bellows, whereupon it broke out into a bright flame. Had this herb been placed in the house, near the fire, it might easily have been supposed that a spark had flown into it, which had caused the inflammation; but this was not the case; the herb had kindled of itself. We see from this, that those who are intrusted with the preparation of boiled oils should take care they do not give occasion to dangers by fire, which may excite suspicions of felonious designs, to the ruin of innocent persons in their lives or reputations. I am, &c. W. Tooke.

*(To be continued.)*

## No. 14.

### *Description of a Stove on the Principles of the Swedish Fire-place, with Head-openings, by* CITIZEN GUYTON.*

THE true principles of constructing fire-places, so as to obtain the greatest heat with the least consumption of fuel, have been known for some time in France; but they have been much less generally adopted, than the necessity for economising fuel demands. We see many fire-places so deep as to consume double the quantity of fuel necessary, and yet heat the apartment but faintly, where half the expense might be spared by altering the fire-place according to Count Rumford's plan.

If a chimney smoke, instead of reducing the tunnel to proper dimensions, so that descending currents cannot take place in it, scarcely any remedy is thought of but air-holes, which require the sacrifice of a certain quantity of fuel, to counterbalance the effect of the cold air continually entering.

The use of the Swedish stoves is probably yet rare, from their not having been constructed on just principles, or in the best proportions, at their first introduction. As I have had one made, which appears to many of my friends to produce an astonishing effect, in compliance with their request I shall give an exact description of it, premising however a few principles with regard to fires.

1. The heat produced is proportionate only to the air consumed by the fuel.

2. The quantity of heat produced by a given quantity of fuel is greatest when the combustion is most complete.

3. The combustion is most complete when the fuligi-

* Nichol. vol. 2. p. 24. Abridged from An. de Chim. vol. 41. p. 79.

nous part of the fuel is retained longest in pipes in which it may undergo a second combustion.

4. Of the heat produced none is of use, but what is diffused through the space to be heated, and retained in this space.

5. The temperature in this space will be higher, in proportion as the current of air, which is to renew and keep up the combustion, is less disposed to absorb the heat of this space in passing through it.

Hence we deduce the following obvious consequences:

1. The fire-place must be kept separate from all bodies that conduct heat rapidly.

2. As heat can be produced only by combustion, and combustion can be maintained only by a current of air, this current should be attracted into pipes, where it preserves the requisite velocity, without going away from the place to be heated; so that the heat it deposits in it gradually accumulates in the whole of the isolated stove, to be afterward given out slowly, according to the laws of its equilibrium.

3. When the wood is consumed to such a point as to afford no more smoke, it is of advantage to stop the outlets of these pipes, to keep in the heat, which would be carried into the chimney by the continued current of fresh air, which would necessarily be of a lower temperature.

4. We shall obtain a higher temperature, and preserve it longer, under similar circumstances, if we construct within the stove, or under the hearth and round the fire-place, pipes in which the air derived from without, is warmed before it enters into the apartment to support the fire, or to replace what has been consumed.

These pipes are what have been called heat openings, *(bouches de chaleur,)* because instead of considering their principal object, it is commonly supposed, that they

are made to give a more rapid passage to the heat produced. This is not totally without foundation, since the temperature of the air issuing from them is increased by the heat it absorbs from the stove; and on this account some might be disposed to neglect them, as contrary to the most essential object, that of retaining the heat in it; but it is to be observed, that we can shut these outlets when we please; and that we may even cut off all communication with the external air by means of a simple slider; so that every advantage may be derived from them without any inconvenience. It must be added, that they are necessary in very close apartments, unless we would expose ourselves to currents of cold air. These reasons have induced me to employ the heat openings in the Swedish stove, to which they had not been applied.

The Swedish stoves are constructed strictly according to the truest principles, and the pipes in which the smoke circulates, are disposed in the best manner for effecting its complete combustion. Their utility has been found so great, that they have become general in Sweden, where the winters are very severe, and where they have diminished the consumption of wood one third, so that there is no country where the inclemency of the weather is guarded against at less expense. They have likewise been employed advantageously, with the necessary variations of form, in dye-houses, breweries, &c.

Their construction is by no means expensive; they save iron-work, and require only bricks or tiles. These are recommended to be placed edgewise, and chosen as thin as possible for the inner walls. The circulating pipes are to be placed so, that rain falling down the chimney can never get into them. The method of using them is so easy, that in the largest public buildings one person is sufficient to light all the fires. All the wood that can be contained in the fire-place, which is very small, is to

be put in at once; it is to be sawn into pieces of equal lengths; and as soon as it is burned, the slider that stops the communication of the circulating pipes with the chimney is to be thrust in. By these means all the heat, which the fuel is capable of producing, remains in the pipes, and issues out slowly, and only to diffuse itself in the apartment; while a single piece of wood, that had not burned at the same time with the rest, would oblige the slide to be left open, and the current of air necessary for its combustion would carry off into the chimney the greater part of the heat produced.

The following is a description of the stove constructed under my directions.

Fig. 1, Plate 3. represents a front view of the stove: its height is 164 centimetres (about 61 inches French,) exclusive of the vase, which is a separate ornament, merely placed on the top.

Its breadth is 85 centimetres (about $31\frac{1}{2}$ inches.)

Its depth 58 centimetres (about $21\frac{1}{2}$ inches.)

The height may vary according to the size of the apartment, and be extended without inconvenience to two metres (about 6 feet 2 inches.) It may likewise be reduced, as I have done for stoves in a laboratory, which were to support a sand bath as high as the hand.

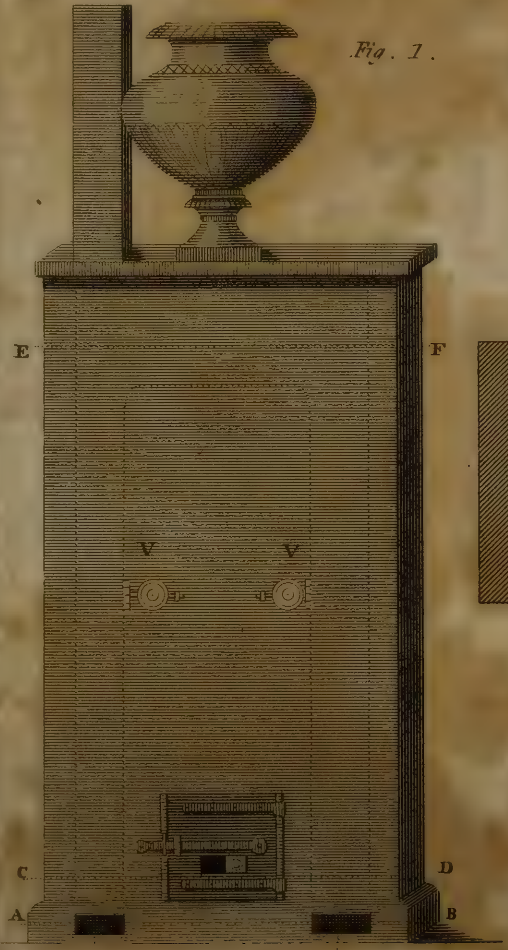
The other two dimensions are determined by those of the bricks employed to form the interior circulatory pipes, which should be in certain proportions, that the smoke may pass through them freely, without so much air entering with it as would condense it, or sink the temperature below the degree necessary for combustion.

V V are the external parts of the two heat openings.

*m m* Apertures of the stove, by which the air, that is to issue through the heat openings, enters. These are closed when the air is drawn from without through a pipe passing under the floor; which is much more advanta-

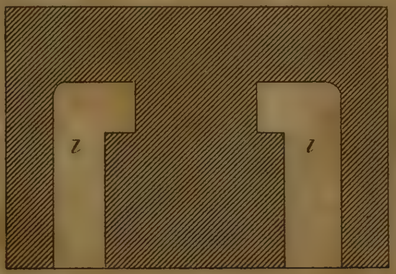
## Blasting Rocks under water.


## Stove of M. Guyton.




C. Tiebout sc.

Fig. 2.



*Section of the Stove of Guyton.*

*Fig. 7.*

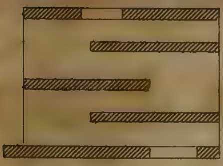


*Fig. 4.*

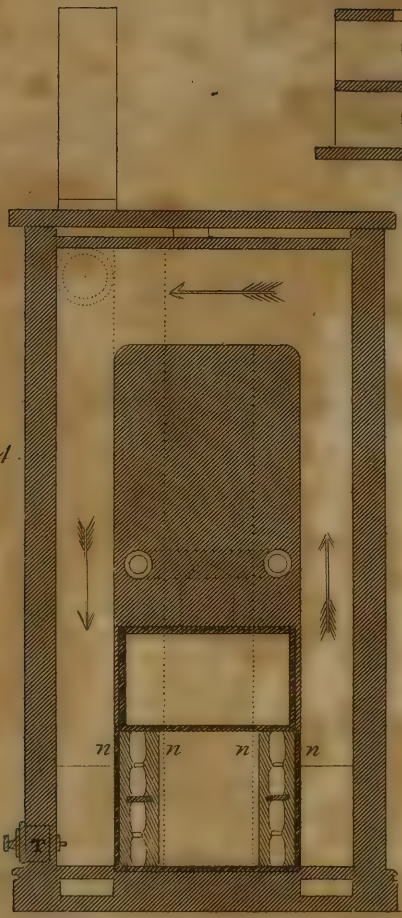



*Fig. 6.*

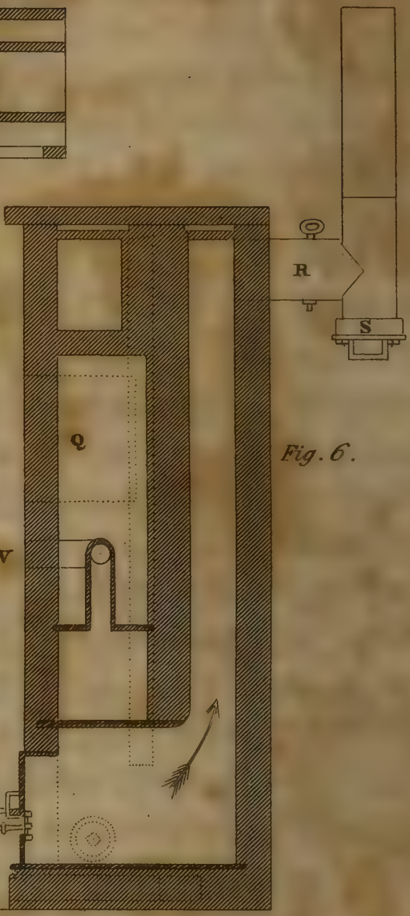



*Fig. 3.*

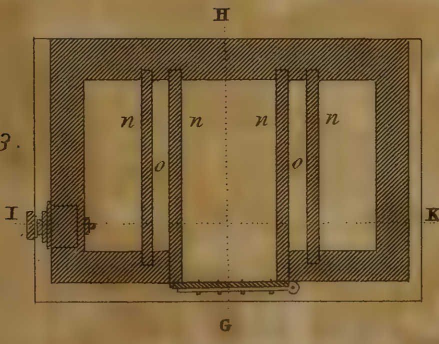
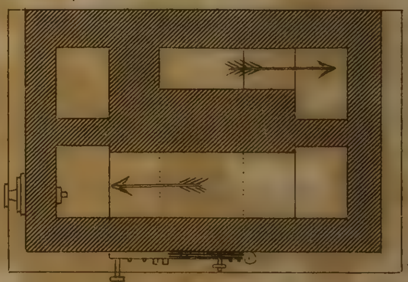



*Fig. 5*



*C. Tiebout sc.*

geous for renewing the respirable air of the apartment, and prevents the danger of currents of cold air attracted by the fire; and which is necessary, as I have observed, whenever the volume of air in the apartment is not sufficient, to supply both the consumption of the fire, and the circulation in the heat pipes.

Fig. 2. is a plan of the foundation of the hearth at the height of the line A B, fig. 1. *l l* are empty spaces, to receive the air, and convey it into the compartments, where it is to be heated before it issues by the heat openings, whether the air be obtained from without, or simply by the apertures *m m*, fig. 1.

Fig. 3. pl. 4. plan at the height of the line C D, fig. 1; that above the door of the fire-place, *n n n n* are the double plates of cast iron, forming the compartments in which the air is to receive the effect of the heat of the fire.

*o o* The empty space between these plates.

Fig. 4. Front section at the line I K, fig. 3. The arrows indicate the direction of the smoke in the circulatory pipes of the front part.*

In this the plates of iron *n n* are seen in their perpendicular situation, with the tongues which form their compartments on each side of the fire-place. One of these plates is represented in front fig. 7.

T is an opening left at the bottom of the fourth circulatory pipe, to restore the draught of air in the fire-place, if necessary, by burning there a few slips of paper, or other light combustible; I say *if necessary*, because I have found by experience, that this precaution may be

* Among the number of Swedish stoves described and delineated in the collection published by baron Cronstedt there are several, the circulating pipes of which pass under the hearth. This gives them a little more extent no doubt, but as soon as the hearth is covered with ashes, the air passing beneath can receive but a very slight impression of heat; it obliges the fire-place to be raised higher; and it renders the construction more complex and expensive. For these reasons I have adopted the most simple plan.

neglected, as soon as the stove has been heated so as to have lost all its internal dampness.

The door of this sort of blower, or air-vent, ought to shut very close. For this purpose it is sufficient, to cut a piece of brick of the proper size, to make a hole in it to receive a handle, and to fasten upon it a piece of plate iron projecting a little all round it.

Fig. 5. Plan at the height of the line E F, fig. 1.

Fig. 6. Transverse section at the line G H of fig. 3, which shews the height of the fire-place, and the first direction of the flame.

V points out the arrangement of the heat pipes.

The dotted lines give the profile of the party walls, which form the four grand circulating pipes.

R the pipe which conveys the smoke from the circulatory pipes into the chimney, and in which is the register that cuts off the communication. It is a common stove tunnel of plate iron; but it would be better to use a substance more slowly conducting heat, as an earthen tube made on purpose, for that part in which the slider or stop plate acts.

The elbow made by this pipe to reach the chimney renders it unnecessary to repeat, that it is a point of the first importance for the body of the stove to be completely separate from the wall. That which I have described is 25 centimetres (about 9 inches) distant from the nearest point of the nich in which it is placed.

S is an elongation of the perpendicular pipe that enters into the chimney. It is intended to receive the water that might condense in the upper part, to prevent it from getting into the stove. The cap at the end of this elongation allows the pipe to be cleaned without taking it down.

The dotted lines forming the square space Q mark a place where a nich may be made, or a sort of little stove, as is done in some of the Swedish stoves, and would ad-

vantageously supply the place of the brick-work, with which it must otherwise be filled up.

All these figures being drawn on the same scale, there will be no difficulty in preserving the proportions of the parts.

The construction of this stove is neither difficult nor expensive. For the outside nothing is wanted but Dutch tiles, such as are used for common stoves, that is to say thin in the middle, and having a border all round, which serves to give them more stability. They are fixed in like manner by a band of metal. The hind part may consist entirely of bricks. The vase placed on the slab of marble or stone, which covers the stove, is a mere ornament.

If it be thought proper to have no heat openings, all the interior structure may be made of bricks of proper sizes, laid with loamy earth moistened, and set on edge for the circulatory pipes, without any iron except a cast plate over the fire-place, and a door and frame in the usual manner.

The expense of the heat openings however consists only in four cast iron plates with tongues and grooves to form the compartments represented at fig. 7. All the rest is done with plate iron, bent round and rivetted, which, when once enclosed in the masonry, will not admit the escape of the air.

Cast iron plates with grooves are well known, since Franklin's stoves have been adopted. If it were found difficult to procure them, their place might be supplied in two ways. First by portions of pipes of cast iron, which might be placed vertically side by side, serving as the inside walls of the fire-place, and communicating with each other by little channels at top and bottom formed in the masonry. Secondly, by common plain cast plates,

soft enough to admit of being bored, so as to rivet on bent slips of plate iron, which would perfectly answer the purpose of the tongues and grooves. As these would never be exposed to the action of the flame, there is no reason to fear their casting. The latter of these two methods is obviously the most advantageous, as it occupies less room, and yet affords more surface to receive the action of the heat, and communicate it to the circulating air.

In concluding my description of this stove I ought not to omit saying, that nearly two years experience has convinced me of the good effects of its proportions.

It is placed in a room fronting the north, the floor of which measures 47 metres square (about 12 toises $\frac{1}{3}$) and which is 42.5 decimetres (13 feet) high.

Every day a log of wood 28 or 30 centimetres (10 or 11 inches) round, sawn into three pieces, or an equal quantity of smaller wood, is burned in it at once. The slider of the door of the fire-place is shut, and the key R, fig. 6, is turned, as soon as the wood is reduced to charcoal. Ten hours after the air throughout the room is at a temperature above the mean; and the centigrade thermometer, placed 36 centimetres (above 13 inches) from the stove, rises rapidly to 16 or 17 degrees.

To shew still more plainly to what degree the economy of fuel and preservation of heat may be carried by this construction, I shall relate another experiment, which I have repeated on several occasions, and which has always afforded me very nearly the same results.

The thermometer in the room, in which there was no fire the day before, being between 9 and 10 degrees, a log sawn in three as usual was put into the fire-place about eleven in the morning; and at three in the afternoon a similar quantity of fuel was put in.

At four o'clock the thermometer, placed at the distance above-mentioned, was at 42 degrees.

At five, at 37 degrees.
At seven, 34.
At nine, 31.
At midnight, 26.

You could not bear to touch with the hand the iron rim of the heat openings. The bulb of the thermometer being placed opposite one of these openings, at the distance of 8 centimetres (about 3 inches) rose in four minutes to 35°.

The next morning at 9 o'clock the thermometer, which had been again placed at the distance of 35 centimetres, was at 22°.

Finally at noon, that is to say twenty-one hours after the last wood was put in, and eighteen hours after the key had been turned, all the wood being reduced to charcoal, the thermometer stood between 18° and 19°. It was then placed two centimetres only from one of the heat openings, and in less than six minutes it rose to 26°.

These effects are so different from what we commonly obtain by the consumption of three or four times as much fuel, that I may expect more than one reader to suppose them exaggerated; but I hope a sufficient number will be found disposed to make trial of these stoves, that their testimony and example may at length triumph over our habits, and produce a general conviction, that, without suffering any privation ourselves, we may preserve for our offspring what useless waste is daily robbing them of, in an article of the first necessity.

## No. 15.

### *Description of the different Methods of blowing up Rocks under Water. By* A. Baillet, *Inspector of Mines.**

1st, The operation of blowing up rocks, which the French call *tirage des mines*, is not in general attended with much difficulty, when the hole of the mine is pierced in dry compact ground without any fissure or cavity. When the ground is cavernous or hollow, or when water oozes through its pores, it becomes more troublesome, and requires particular care. When it is necessary to blow up rocks at the bottom of the water, the difficulties are increased. In that case the usual processes must be abandoned, and others must be resorted to.

2d, The method of blowing up rocks in the latter case is little known, and not much practised: it may, however, be of great utility in many cases, not only in the working of mines, but in the execution of public works of importance. These motives have induced me to give a description of the three principal methods of blowing up mines under water.

The first is that used in the mines in the northern part of the republic: it is proper to be resorted to when the depth of the water which covers the ground intended to be blown up is not above 15 or 18 decimetres.

The second has a great resemblance to the process usual in mines when the ground suffers the water to ooze through it. It is simpler and less expensive than the preceding, and appears to me to be very proper for cases when there are only a few decimetres of water above the ground.

The third is suited to great depths of water, such as

* Tilloch, vol. 13. p. 268. From the Journal des Mines, No. 56.

4, 5, or 6 metres : it is that employed at Carlscrona. It is very ingenious, and seems hitherto to have been unknown to the French miners.

3d, But, before I begin to describe these methods, it may be of some use to mention here an interesting memoir, printed in the Journal de Physique for the year 1779, on the construction of air-boats proper for facilitating the execution of all sorts of works under water, without employing pumping. C. Coulomb, the author of this memoir, after describing the method of constructing the air-boat, shews in what manner it is to be used. He points out the means by which it may be made to sink at pleasure, of placing the workmen under the box, of continually renewing the air, of removing the rubbish and laying a foundation of mason-work at the bottom of deep water. He then calculates the time necessary for removing a metre in height from the bank of Quille-bœuf, which interrupts the navigation of the Seine ; and foreseeing the cases in which mattocks or pick-axes would be insufficient for clearing obstructions from the bottom of the water, and where the hardness of the rock might require the use of gun-powder, he proposes two methods of blowing up rocks under water.

In one, the workman placed under the box bores the rock, and introduces into the bottom of the hole a box of tin plate filled with gun-powder, to which is soldered a small tube, also of tin plate, which rises above the water at ebb-tides, and which is stopped with some greasy matter, after having been filled with a very weak composition to serve as a train. The sea, as it rises, makes the air-boat float ; and when its lower edge has risen higher than the extremity of the tube, it is then removed, and when the ebb-tide uncovers that extremity, a person goes in a boat and sets fire to it.

In the other method, which the author proposes for

the Mediterranean, and rivers where the assistance of the tide cannot be employed, the tube of tin plate which contains the train rises only 3 decimetres above the rock, but is terminated by a leather pipe covered on the outside with some water-proof substance, and in the inside with an incombustible varnish, and secured from the pressure of the water by a spiral winding made of wire. Its extremity must be carefully closed, and a buoy attached to it carries it to the surface of the water when the air-boat is afloat.

4th, I shall say nothing further of these methods, which suppose, as may be seen, the assistance of the air-boat. I only wished to point them out, because they may be useful in many cases, and may, besides, give rise to new ideas, and serve to modify the three particular methods which are the object of this memoir.

## I. *Method of blowing up Rocks at the Depth of* 15 *or* 18 *Centimetres under Water.*

5th, This method consists in the following operations:

First, bore the hole at the bottom of the water by the help of borers, and instruments of proper length.

Then place in the hole a tube of tin plate closed at the lower extremity. The exterior diameter of this tube is of such a size that, when introduced into the bore, it may fill it; and its length must be such as that it shall rise some centimetres above the surface of the water.

Then send down to the bottom of this tube the cartridge filled with powder; introduce the priming rod, and ram round it clay or plaster according to the usual process, and only to the height corresponding to the summit of the hole.

In the last place, draw the priming rod and introduce the train, and set fire to it with all the necessary precautions, that the workmen may be sheltered from danger at the time of explosion.

*Observation.*

6th, This method has been often employed with advantage in several mines of the republic: it may serve either for deepening wells, or making other excavations, when the means used for keeping the ground and bottom of wells constantly dry are insufficient.

## II. *Method proposed for blowing up Rocks some Decimetres below Water.*

7th, When the ground or rock to be blown up is covered only by some decimetres of water, the miner can see the rock which he bores, and the hole to be loaded, with as much ease as if there were no water, and can work with the same facility. In this case, to save expense, the tube of tin plate may be omitted, and a cartridge of pitched cloth, such as that employed in ground through which the water oozes in every part, may be employed, adapting to it a rod of hollow wood * destined to contain the train that conveys the fire to the powder. The diameter of the aperture of this rod may be only a few millimetres, and its length must exceed the upper level by some centimetres.

8th, If this method be adopted, first construct a cylindric cartridge of cloth or pasteboard, and fill it with gunpowder; insert into it the rod, which must descend to the middle of the length of the cartridge without approaching the interior surface of the wrapper; pinch closely the upper part of the cartridge around the rod, and cover the cartridge and whole rod with pitch or some kind of varnish.† Then send down the cartridge furnished with its rod into the hole of the rock, and drive in strongly two plugs of dry wood to serve as wadding.

* This rod might be made of the elder or honeysuckle.

† A solution of Spanish wax in alcohol is attended with the advantage of drying speedily, and of remaining water-proof for a long time.

These plugs must have a longitudinal groove, that they may glide along the rod and suffer the water to escape.

### *Observation.*

9th, Instead of a rod of hollow wood you may employ, with advantage, either a tube of tin plate about four millimetres in diameter, terminating at the lower extremity, which must be inserted in the cartridge in a truncated cone, and an orifice of two millimetres; or a leaden pipe drawn in the manner of wire-drawers, having the same dimensions as the above, and whose resistance may be sufficient, if you take care to introduce into it, while you drive in the wadding, a rod which may exactly fill the interior vacuity.

If you have at hand any kind of composition capable of acquiring hardness in a little time * at the bottom of the water, you may substitute for the rod and metallic tubes a flexible tube of cloth done over with pitch or gum. In this case, it will be necessary to introduce the priming rod into the tube, while you drive in the wadding to prevent its depression. The cloth of the tube, the upper extremity of which is destined to rise above the hole in the rock, must be sufficiently thick and strong that the pressure of the water, which I suppose to be some centimetres above the ground, may not flatten it, even if the liquid should introduce itself between the tube and the composition.

### III. *Method of blowing up Rocks under Water at any Depth.*

10th, This method, on the first view, has a resemblance to that first described, since a tube of tin plate is employed in it; but it differs essentially from it in this

* A mixture of quicklime and plaster newly calcined would, perhaps, be of this kind.

respect, that instead of wadding above the charge, according to the usual method, you employ an inflexible shank charged with a weight at its upper extremity, and terminating at the lower in a segment of an iron cylinder, which performs the office of a wedge, and is applied exactly npon another similar wedge inverted and resting on the upper end of the cartridge.

The effect of this disposition, as may be readily conceived, is to force the wedge which adheres to the cartridge to ascend a little at the time of the explosion, and to squeeze itself closely against the upper wedge so as to close the hole in the rock.

11th, The description of this process may be seen in the twelfth volume of the Memoirs of the Academy of Stockholm; I shall therefore give a literal translation of it.*

## IV. *New Method of blowing up Rocks under Water, by Daniel Thunberg.*

A profile of the rock which has been bored, and into which the charge is introduced, is represented Plate 3. fig. 8.

The charge is contained in a tube of tin plate impermeable to water, a vertical section of which is represented in the same figure. The lower extremity of this tube must be adjusted properly to the hole which has been bored in the rock.

The charge consists of a paper cartridge filled with gunpowder, and attached to the iron wedge *b* with a thread such as that used for sewing sails.

To this first wedge *b* is applied another *c*, which adheres to an iron rod that rises above the tube.

* Details respecting this process may be found also in a large work entitled *Description des Travaux executés a Carlscrona, par* Daniel Thunberg.

On the plane face of these wedges is a groove made with a file which reaches to the powder: this groove is continued throughout the whole length of the tube of tin plate by means of a wooden rod *d*, hollow on the side turned towards the iron rod, to which it is made fast with strong packthread.

Before this rod is attached to the iron one, a match, which proceeds from the upper extremity and communicates with the interior of the cartridge, is placed in the groove.

*e* is a train applied to the end of the match.

B C are two rafts which enable the workmen to bore the rock and blow it up.

D is a weight which prevents the iron from being repelled too far when the explosion takes place.

E F G H I are different pieces necessary for charging. E is the cartridge furnished with its wedge, seen sideways; F the wedge seen in front; G the wooden rule and its groove; H the upper wedge and its iron rod; I the tube of tin plate; K section of the wooden rule and its groove.

When the rock has been bored according to the usual method by employing a borer pretty strong and of such a length as the depth of the water may require, introduce into it the tube into which the charge has been put; then apply the train *e*, and having placed the weight D above the rod, set fire to it. The explosion will immediately take place: the wedge *b* would be expelled but for the wedge *c*, which cannot give way; and the two wedges being thus united, confine the charge, the effect of which will never fail, as has been proved by experience.

Four feet of the tube and the lower wedge are in general lost; but the upper wedge may be employed for new charges, because it is never damaged.

*Observation.*

12th, This method, the success of which is proved, deserves, no doubt, to be known by all those engaged in great undertakings, and who have frequent occasion to apply it.* It is, perhaps, susceptible of being modified; and it appears to me that, without employing the impermeable tube, a varnished cartridge might be used, with a flexible tube proceeding from it, lodged in the groove between the two wedges, and then rising above the water.

Fire also might be conveyed to the powder below the water by means of a strong discharge of electricity; but little can be expected from this method in the hands of workmen.

In the last place, the lower wedge might be made of hard and very dry wood.

13th, But, in whatever manner this method may be employed, it will not require great expense, and it may be used with great advantage for deepening ports, rendering certain harbours more convenient and safe, and for freeing rivers and streams from those rocks which obstruct their course and impede the navigation of them.

* Mr. Daniel Thunberg employed the same means to raise large blocks of stone from the bottom of the water. For this purpose a hole is bored in the block with a miner's borer to the depth of twenty or twenty-five centimetres. Two wedges are introduced into it, forming by their junction a cylinder so as to fill the hole. Several blows are then struck on the iron bar which adheres to the upper wedge: the two wedges are then closely squeezed together, and the block is raised out of the water by means of a windlass and a cord attached to a ring fixed in the lower wedge.

## No. 16.

[The intention proposed in introducing the following papers of Mr. De Saussure, is, to point out to persons in different parts of the United States those various objects of inquiry which they may have it in their power to make, and which may subserve the interests of science; at the same time a large mass of important information may be collected into a point, which may eventually prove beneficial to the country, by unfolding the resources we possess within ourselves. Many intelligent settlers of our western territory will no doubt be glad to have subjects of general inquiry pointed out to them; whilst those more peculiarly local will readily occur from their own observations.] Ed.

### *Agenda; or a Collection of Observations and Researches the results of which may serve as the Foundation for a Theory of the Earth. By* M. de Saussure.*

When about to contemplate objects so complex as those that must be studied to found on observation the basis of a theory of the earth, it is indispensably necessary that we should previously form a regular plan; prescribe for ourselves a certain order; and minute down, if I may use the expression, the questions which we wish to propose to nature. As the geologist commonly studies and observes while travelling, the least distraction may deprive him, perhaps for ever, of an interesting object. Even without interruption the objects of his study are so various and so numerous, that some of them may easily escape his notice. An observation which appears important, by engaging his whole attention, makes him often forget others: sometimes he is discouraged by bad weather, or becomes absent through fatigue; and the neglect produced by all these causes gives rise to deep regret, and even frequently obliges him to turn back;

* Tilloch, vol. 3. p. 33. From the Journal des Mines, No. 20.

whereas if he has a collection of memorandums on which he can from time to time cast his eye, he will be reminded of all those objects which ought to engage his attention. This collection, confined at first, will be extended and improved in proportion as he acquires ideas, and may furnish hints to travellers who, without being versed in geology, wish to collect, in the countries they visit, observations that may be useful to those who study that science.*

Agreeably to these principles, I have always prepared for all my journeys a list of those objects, for examining which that journey was intended. I propose here, however, a more extensive plan. I wish to direct the traveller, and even the sedentary philosopher, in all the researches which ought to engage their attention, if they are desirous of contributing towards the progress of a theory of our globe. I do not flatter myself that I shall be able to give a complete view of every thing that remains to be done: what I offer will be only an imperfect sketch, but this sketch will be at least useful till some one produce a better. Several of the observations and questions which I here propose as problematic, seem indeed to have been already resolved; but as most solutions of this kind are founded merely on analogy, the contrary of which is always physically possible, it is proper, in my opinion, to keep the eyes of naturalists always open to the grand facts which may be interesting to a theory so difficult and of so much importance.

## CHAP. I.

### *Astronomical Principles.*

1. A general system of cosmology, in what regards the earth considered as a planet.

* Voyage dans les Alpes, vol. 1. Preliminary Discourse.

2. The figure and dimensions of the earth determined.

3. The density of the earth determined by the deviation of a plummet near some mountains, the dimensions and density of which are known.

4. Whether any principles or hypotheses, depending on astronomical geography, can explain the great changes in the temperature of some parts of our globe?

5. The courses of comets. Whether it be possible that they may have met with, or still meet with, the earth in their orbits, and what are the effects of such a meeting?

6. Whether it be possible, I do not say probable, that a comet, by passing through part of the sun, may have detached from it the earth and the other planets?

7. Is it probable that the earth's rotary motion has been formerly more rapid than it is at present?

8. If the grand chains of mountains existed before the rotary motion of the earth, is it possible that that motion produced any change in their original situation?*

## CHAP. II.

### *Chemical and Physical Principles.*

1. The theory of attraction and chemical affinities; of solution, crystallisation, and precipitation.

2. The theory of elastic fluids in general, and the cause of their elasticity.†

3. The theory of caloric and light; of the origin and nature of the different gases, and of the atmosphere. Electricity, and the aurora borealis.

4. The theory of the calcination of metals, and of the decomposition of water.

5. Measuring heights by the barometer.

* Tableau des Etats Unis. Note of M. A. Pictet, p. 125.

† System of M. Le Sage.

6. How the temperature of climates is modified by the winds, evaporation, the nature and elevation of the ground.

7. Whether these causes are sufficient to explain certain changes, such as that of the plants and animals of warmer countries having been able to exist and multiply in the coldest countries?

8. Mineralogy, the nature of earths, stones, salts, bituminous substances, and metals. The principles of their analysis and nomenclature.

9. If it be possible to transmute one earth or one metal into another. For example, if it be possible that siliceous earth can be changed into calcareous earth in the bodies of marine animals; or, reciprocally, that calcareous can be changed into siliceous earth in mountains of chalk?

10. If it be probable, according to the conjecture of Lavoisier, that earths are the oxyds of metals?*

11. What idea can we form of one or more solvents which, either simultaneously or successively, may have rendered soluble in water the different mineral substances which we see on the surface and in the bowels of the earth?

12. Can we believe that these solvents may have been afterwards destroyed; and that it is in consequence of their destruction that the matters they held in solution were precipitated and became crystallised?

12. A. Or, can we believe, with Dolomieu, that all crystallizations may take place without previous solution; and that it is sufficient for this operation that the bodies be reduced to their elementary parts, and that these parts be suspended in a fluid which gives them liberty to unite by their corresponding faces?

* Since verified by Davy and others. Ed.

13. Can we suppose that the electric and magnetic fluids enter, as elements, into the composition of bodies?

14. Does it appear probable that the nitric, muriatic, and boracic acids, as well as the three alkalies, are of new formation; while the sulphuric, phosphoric, carbonic, tungstic, molibdic, and arsenic acids existed before the formation of animals?*

15. If we believe that the mineral alkali or soda was of ancient formation, may we not suppose that the ancient ocean held this alkali in solution? That would explain how it might have dissolved siliceous earth and argil without being able to nourish animals. Afterwards, when the marine acid was formed, or had issued from some cavity, the sea might have become proper for animals, and improper for the solution of siliceous earth and argil.

16. Is it probable that in the first ages of the existence of our globe its atmosphere was higher than at present; that its lower strata were thus of a much greater density, and susceptible of receiving from the sun a greater heat?

17. May we presume that the waters of the ancient ocean, before the formation of the primitive mountains, had a heat superior to that of boiling water?

18. What temperature may we suppose at present to exist at the centre of the earth?

19. Is it possible that the quartzy earth found in petrified vegetables and animals has proceeded from the substance of these bodies?

## CHAP. III.

### *Historical Monuments.*

Though the grand revolutions of our globe have been anterior to all histories and monuments of art, light may,

* Theorie de la Terre de M. de Lametherie.

however, be acquired from the traditions which history has preserved :*

1. In regard to the situation of those countries which were first inhabited.

2. In regard to the order in which they were successively inhabited.

We shall thence see whether it be true, as some traditions assert, that this habitation was determined by the progressive retiring of the waters; and by coming to periods less remote and less involved in obscurity, history may point out to us—

3. The changes undergone by the seas, lakes, rivers, and even some of the solid parts of the globe.

4. It will throw some light on the origin of the different races of men and animals; on the modifications they have experienced; and on the real or pretended loss of some of these races.

5. The deluges or great inundations; their epochs and extent.

6. Whether there exist proofs of the diminution of the water of the sea; and what may be the cause of it?

7. If it be probable that large caverns have been opened in the bowels of the earth, and that these caverns swallowed up a part of the waters?

8. Do there exist any historical monuments which prove that the countries at present cold were formerly so warm as to favour the multiplication of plants and animals which are no longer found but in the torrid zone?

## CHAP. IV.

### *Observations to be made on the Seas.*

1. Their form, extent, and situation; those of their great gulfs and straits; their relative elevation.

* And also from the analogy between the languages and customs of different countries. Tr.

2. The sensible flux and reflux out of the ocean, at the extremity of some gulfs and in some straits; their periods and their limits.

3. Their bottom; notes of the places where they are deepest, and of the most remarkable shoals; their position and extent.

4. Currents at the surface or at different depths; their direction, velocity, and limits; their relation to rivers, the winds, and form of the coasts; the matters which they accumulate, and the places where they deposit them.

5. Subterranean mountains and valleys; their relation with islands, and even with the terrestrial mountains and valleys.

6. The nature of the mud, sand, and rocks, of which the bed of every sea is composed.

7. An analysis of the water of the different seas; and, at least, their saltness at different depths and in different climates.

8. Their temperature at different depths and in different climates.

9. The fish and testaceous animals peculiar to different seas, depths, and climates, which may serve to characterise them.

10. In what the present seas differ, in a physical and chemical view, from the great ocean, which, according to some systems, is supposed to have covered the whole surface of our globe?

11. Can we believe that there are still formed stony strata at the bottom of the seas, and that their waters have consequently that dissolving power which is supposed to have belonged to the ancient ocean?

## CHAP. V.

### *Observations to be made on the Borders of the Sea.*

1. If the sea coast is steep; if it forms steep hills, to observe their height, their nature, and the strata of which they consist.*

2. To seek on these hills traces of the effects or abode of the waters at different heights above the present level, and at different depths below, such as furrows, caverns, shells, pholades; to search also for vestiges of the labours of man, such as excavations, rings for making vessels fast; in a word, to endeavour to ascertain whether the sea has the same level as it had in the remotest ages.

3. In case the level has changed, to examine whether that effect has been produced by a change in the sea itself, or whether the shore rather has not been raised or depressed.

4. If the sea coast is flat, to discover to what distance its acclivity is insensible; and to examine the nature of the sand found on the shore.

5. Whether the grains of that sand are round or angular, crystallised or not, quartzy or calcareous, or of any other kind of stone.

6. To endeavour to discover its origin, whether it can be considered as produced by detrition from the neighbouring mountains or hills; whether it may not have proceeded from some river which had its mouth in the neighbourhood, or whether it may not have been brought from the bottom of the sea itself by the tide and the waves?

* 1. A. To note down every thing that relates to the destruction, more or less rapid, of these hills, and the banks and accumulations formed chiefly at the mouths of rivers. Til.

7. Whether this sand contains, like that of Rimini, microscopic shells of the order of those called *pelagian?*

8. Whether there are not shells on the borders of the sea; and, if there are, to determine those by which that coast seems to be characterised.

9. Whether there are any rolled pebbles?

10. To examine, as in No. 2, chiefly on the shore, and even pretty far up the country, whether there are any proofs that the sea gains on the land, or the latter on the sea; and, in case the sea seems to recede, to discover whether that may not be occasioned by the land rising by accumulations washed down from the higher grounds; by subterranean causes, or reciprocally.

11. If a progressive displacing of the ocean really exists, by what observations can the systems, which tend to explain it, be verified? Some have employed, for that purpose, the currents produced by the trade winds; others, the shock of the tides and currents; and others, a change in the earth's centre of gravity, occasioned either by deposits transported by rivers to the sea, or by the progressive movement of some mass detached from the interior parts of the earth supposed to be concave.*

*(To be continued.)*

* 12. To observe whether there are not daily formed different kinds of stones in the places which are washed by the waters of the sea. Til.

## No. 17.

[The valuable information contained in this treatise on the cultivation of the vine, &c. must render it highly important to those persons who are inclined to pursue the subject in the United States. It will occupy some part of the subsequent numbers of the present volume of the Emporium.] Ed.

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## *A Treatise on the Cultivation of the Vine, and the Method of making Wines. By* C. Chaptal.*

There are few natural productions employed by man as aliment, which he has not altered or modified by preparations which remove them from their primitive state. Corn, flesh, and fruits, are all subjected to a commencement of fermentation before they are used as nourishment; and peculiar qualities are given even to objects of luxury, caprice, or whim, such as tobacco and perfumes.

But it is in the fabrication of liquors in particular that man has displayed the greatest sagacity: all are the work of his own creation, water and milk excepted. Nature never furnishes spirituous liquors: it suffers the grapes to rot on the stems, while art converts the juice into an agreeable, tonic, and nourishing liquor called *wine.*

It is difficult to ascertain the precise period when mankiud began to make wine. This valuable discovery seems to be lost in the darkness of antiquity, and the origin of wine has its fables, like all other things which have become objects of general utility.†

* Tilloch, vol. 9. p. 21. From Cours d'Agriculture de Rozier, vol. 10.

† Two or three pages are here omitted, which are merely speculations on the origin of wine, &c. derived chiefly from the ancients. Ed.

### I. *On Wine considered in regard to Climate, Soil, Exposure, Seasons, Culture, &c.*

1st, *Climate.*—All climates are not proper for the cultivation of the vine: if this plant seems to vegetate with vigour in the northern climates, it is certain that the fruit can never there acquire a sufficient degree of maturity; and it is an invariable truth, that beyond the 50th degree of latitude the juice of the grape cannot experience that fermentation which converts it into an agreeable beverage.

The case with the vine in regard to climate is the same as with other vegetable productions. We find towards the north a vigorous vegetation, plants well nourished, and succulent; while the south exhibits productions charged with aroma, resin, and volatile oil; here every thing is converted into *spirit,* there every thing is employed to produce *strength.* These characters, so striking in vegetation, occur in the phænomena of animalization; where *spirit* and *sensibility* seem to be appendages of the southern climates, while *strength* seems to be the attribute of the inhabitant of the north.

Travellers in England have observed that some of the insipid vegetables of Greenland acquire taste and smell in the gardens near London. Reynier found that the melilot, which has a strong penetrating smell in warm climates, retained none in Holland. Every body knows that the highly subtile poison of certain plants and animals is successively blunted or extinguished in the individuals reared in climates further towards the north.

Sugar itself seems not to expand in a complete manner but in warm countries. The sugar-canes cultivated in our gardens furnish scarcely any saccharine principle; and grapes are sour, harsh, or insipid, beyond the 50th degree of latitude.

The aroma, or perfume of the grapes, as well as the sacchariue principle, are the production then of a bright and a constant sun. The sour or harsh juice produced in grapes during the first period of their formation cannot be properly matured in the north, and this primitive character of greenness still exists when the first frosts come to freeze the organs of maturation.

Thus, in the north, the grapes rich in principles of putrefaction contain scarcely any element of spirituous fermentation, and the expressed juice of the fruit, having experienced the phænomena of fermentation, produces a sour liquor, in which there exists only that proportion of alcohol necessary for interrupting the movements of putrid fermentation.

The vine, therefore, as well as the other productions of nature, has climates peculiar to itself: it is between the 40th and 50th degrees of latitude that this vegetable production can be cultivated with any degree of advantage. It is also between these points that the most celebrated vineyards are found, and the countries richest in vines; such as Spain, Portugal, France, Italy, Austria, Styria, Carinthia, Hungary, Transylvania, and a part of Greece.

But of all countries none perhaps presents so happy a situation for the vine as France; none exhibits so large an extent of vineyards, nor exposures more varied; and no country has such an astonishing variety of temperature. From the banks of the Rhine to the bottom of the Pyrenees, the vine is almost every where cultivated, and in this vast extent the most agreeable and most spirituous wines of Europe are to be found.

But though climate stamps a general and indelible character on its productions, there are certain circumstances which modify and limit its action; and it is only by carefully attending to what each of them produces that we

can be able to discover the effect of climate alone. It is thus that we often find the different qualities of wine united under the same climate, because the soil, exposure, and cultivation, modify and mask the immediate action of that grand agent.

On the other hand, there are some vine plants which do not leave us the choice of cultivating them indiscriminately in any latitude at pleasure. Soil, climate, exposure, cultivation, all ought to be appropriated to their inflexible nature; and the least violation of this natural character essentially alters the product. Thus, the vines of Greece transported to Italy no longer produced the same wine; and those of Falernum, cultivated at the bottom of Vesuvius, have changed their nature. It is confirmed by daily experience that the plants of Burgundy transported to the south no longer produce wines so agreeable and delicate.

It is therefore proved that the characters by which certain vines are distinguished cannot be reproduced in different sites; for this purpose the constant influence of the same causes is necessary, and, as it is impossible to unite them all, the consequence must be changes and modifications.

We may therefore conclude that warm climates, by favouring the formation of the saccharine principle, must produce wines highly spirituous, as sugar is necessary to their formation. But the fermentation must be conducted in such a manner as to decompose all the sugar of the grapes, otherwise the result will be wines exceedingly luscious and sweet, as has been observed in some of the southern countries, and in all cases where the saccharine juice of the grapes is too much concentrated to experience a complete decomposition.

The cold climates can give birth only to weak and exceedingly aqueous wines, which have sometimes an

agreeable flavour; the grapes, in which scarcely any saccharine principle exists, cannot contribute towards the production of alcohol, which forms the whole strength of wines. But, on the other hand, as the heat arising from the fermentation of these grapes is very moderate, the aromatic principle is preserved in its full force, and contributes to render these liquors exceedingly agreeable, though weak.

2. *Soil.*—The vine grows every where, and, if we could judge of the quality of it by the vigour of its vegetation, it is in fat moist soil, well dunged, that it ought to be cultivated. But we are taught by experience that the goodness of wine is never proportioned to the force of the vine. We may therefore say that nature, desirous to assign to each quality of soil a peculiar production, has reserved dry light soil for the wine, and has intrusted the cultivation of corn to fat and well nurtured lands:

> Hic segetes, illic veniunt felicius uvæ.

It is in consequence of this admirable distribution that agriculture covers with its varied productions the surface of our globe; and nothing is necessary but to avoid deranging the natural order, and to apply to each place the proper cultivation to obtain almost every where abundant and varied crops:

> Nec vero terræ ferre omnes omnia possunt:
> Nascuntur steriles saxosis montibus orni;
> Littora myrthetis lætissima: denique apertos
> Bacchus amat colles.

Strong argillaceous earth is not at all proper for the cultivation of the vine; for not only are the roots prevented from extending themselves in ramifications, as is the case in fat and compact soil; but the facility with which these strata are penetrated by water, and the obstinacy with which they retain it, maintain a permanent state

of humidity, which rots the root, and gives to all the individuals of the vine symptoms of weakness, which soon end in their destruction.

There are some kinds of strong earth which do not possess those hurtful qualities that belong to the argillaceous soil above mentioned. Here the vine grows and vegetates in freedom; but this strength of vegetation still essentially hurts the good quality of the grapes, which can with difficulty acquire maturity, and gives the wine neither spirit nor flavour. These kinds of soil, however, are sometimes set apart for the vine, because its abundance makes up for its quality, and because it is often more advantageous for the farmer to cultivate the vine than to sow corn. Besides, these weak but abundant wines furnish a beverage suited to labourers of every class, and are attended with advantage in regard to distillation, as the vines require little culture.

It is well known to all farmers that moist soil is not proper for the cultivation of the vine. If the soil, continually moistened, is of a fat nature, the plant languishes in it, rots, and dies: on the other hand, if the soil be open, light, and calcareous, the vegetation may be strong and vigorous, but the wine arising from it cannot fail to be aqueous, weak, and destitute of flavour.

Calcareous soil in general is proper for the vine: being arid, dry, and light, it affords a proper support to the plant; the water with which it becomes occasionally impregnated circulates, and freely penetrates through the whole stratum; the numerous ramifications of the roots imbibe it at every pore; and in all these points of view calcareous soil is very favourable to the vine. In general, wines produced in calcareous soil are spirituous, and the cultivation is so much the easier, as the soil is light and not strongly connected; besides, it is to be observed that these dry soils appear exclusively destined for the

vine: the want of water, mould, and manure, oppose the idea of every other cultivation.

But there are some kinds of soil still more favourable to the vine, those which are at the same time light and pebbly: the root easily forces itself through a soil, which, by a mixture of light earth and pebbles, is rendered exceedingly permeable. The stratum of *galets* which covers the surface of the earth defends it from the drying ardour of the sun; and while the stem and the grapes receive the benign influence of that luminary, the root, properly moistened, furnishes the juice necessary for the labour of vegetation. Soil of this kind is called in different countries, stony soil, sandy soil, &c.

Volcanic earth also produces delicious wines. I have had occasion to observe in different parts of the south of France that the most vigorous vines and the most capital wines were produced among the remains of volcanoes. These virgin earths, prepared for a long time in the bosom of the earth by subterranean fires, exhibit an intimate mixture of all the earthy principles; their semi-vitrified texture, decomposed by the combined action of the air and water, furnishes all the elements of good vegetation, and the fire with which these earths have been impregnated, seems to pass in succession into all the plants intrusted to them. The wines of Tokay and the best wines of Italy are the production of volcanic soil; the last bishop of Agde dug up, and planted with vines the old volcano of the mountain, at the bottom of which that ancient town is situated, and these plantations form at present one of the richest vineyards in that canton.

There are points on the variegated surface of our globe where the granite no longer presents that hardness and unalterability which in general form the character of that primitive rock: in these places it is pulverulent, and presents to the eye nothing but dry sand of greater or

less coarseness: it is among these remains that the vine is cultivated in several parts of France; and, when a favourable exposure concurs to assist the increase, the wine is of a superior quality. The famous Hermitage wine is produced amidst similar ruins. From these principles it may be readily judged, that a soil like that of France must be favourable to the formation of good wine; as it exhibits that lightness of soil which permits the roots to extend themselves, and allows the water to filter through it, and the air to penetrate it: that flinty crust which moderates and checks the ardour of the sun; that valuable mixture of earthy elements, the composition of which seems so advantageous to every kind of vegetation.

Thus, the farmer, more anxious to obtain wine of a good quality than an abundant vintage, will establish his vineyard in light pebbly soil; and he will not make choice of a fat rich soil unless he intends to sacrifice quality to quantity.*

*(To be continued.)*

* Though the principles here established are proved almost by general observation, we must not, however, conclude that there are no exceptions. Creuzé-Latouche observes in a memoir read in the Agricultural Society of La Seine, that the valuable vines of Ai, Epernay, and Hautvillers sur la Marne, have the ame exposure, and grow in the same soil and land as those in the neighbourhood. The same author observes, that attempts have been made to convert corn lands into vineyards; but it is probable that the experiments have not been attended with success, and that, consequently, there are causes of difference which cannot be discovered by mere inspection.

This author adds, that the primitive earth in the vineyards of the first rank in Champagne, are covered with an artificial stratum formed by a mixture of turf and rotten dung, common earth taken from the sides of the hills, and sometimes of black and rotten sand. These kinds of earth are carried to the vineyards all the year through, except in vintage time.

## No. 18.

***Observations on Maddering; together with a simple and certain Process for obtaining, with great Beauty and Fixity, that colour known under the name of the Turkey or Adrianople Red. By*** **J. M. Haussmann.***

I have already indicated, in the *Annales de Chimie* † and the *Journal de Physique*, that earths and metallic oxides have more or less the property of attracting and retaining the colouring parts of vegetable and animal substances; alumine and the oxide of iron possess it in a greater degree than the oxide of tin; but the attractive force of the latter far surpasses that of the other earths and metallic oxides in regard to the colouring parts of the said substances.

Alumine and metallic oxides do not retain, with the same force of adhesion, the colouring parts of all animal and vegetable subjects indiscriminately; that of madder adheres much stronger than those of the other colouring substances, which may be classed in the following order: kermes, cochineal, logwood, yellow India wood, woad, quercitron, Brazil wood, red India wood, yellow berries, &c. The gall-nut, shumac, and other astringent colouring substances, act principally by means of the gallic acid, and, in regard to their degree of fixity, may be placed immediately after madder: the case is not the

* Tilloch, vol. 12. p. 170. From the Annales de Chimie, No. 122.

† We must here mention, that C. Chaptal, minister of the interior, a good judge in matters of this kind, when he communicated to us these observations, wrote as follows: "C. Haussmann, manufacturer of printed cottons at Laglebach, near Colmar, in the department of the Upper Rhine, well known among those chemists who apply the discoveries of science to improvements in the arts, transmitted to me the annexed memoir. In my opinion it will be of utility to make it known in your Annals, and the author on my request has consented to its being published." *Note of the Editors of the* Annales de Chimie.

same with the Prussic acid, which communicates a colour to different metallic oxides, from which it can be separated cold by alkaline leys.

To judge of the fixity of colours arising from animal and vegetable substances, the best method is to employ a ley of oxygenated muriate of potash or soda, with excess of alkaline carbonate. The longer or shorter resistance which the colours make in this ley, will indicate what they will make when acid, alkaline, saponaceous, and other reagents are employed.

In the art of dyeing, and that of cotton-printing, the name of maddering is given to that process by which the colouring parts of madder are transferred, by means of water with the aid of heat, to alumine, or to the oxide of iron fixed in any kind of stuff.

The brightness and fixity of the colours obtained from maddering depend not only on the process, but also on the state and purity of the water as well as of the madder. It is therefore absolutely necessary to avoid or to render inactive every acid, alkaline, or saline substance that may be contained in the water, or in the madder itself. I have shown that, by adding carbonate of lime, (pounded chalk,) madder which I suspected to contain gallic acid was corrected; but that my friend Charles Bertholdi, professor in the central school of the Upper Rhine, afterwards found that it was sulphuric acid united to magnesia.

The important discovery of this addition of chalk, which I made twenty-five years ago, has given birth to many manufactories, and improved all those established near waters which do not run over or hold in solution this earthy salt, without which it is absolutely impossible to obtain beautiful and fixed madder colours. This chalk since that time has become a new object of commerce; and as the price is very moderate, I have not yet deter-

mined the just proportion to be employed: in general, I take one part for four, five, or six, of madder.

In order to obtain the brightest madder colours, it is not sufficient to attend to the quality of the water and of the madder: it is necessary also to observe the degree of the heat of the bath: a low temperature will check the attraction of the colouring parts, and prevent them from being extracted, while one too high will favour the adhesion of the yellow particles of the madder, which obscure and tarnish the shades intended to be produced. The only colour which gains by increasing the heat is black. I have always observed, that on withdrawing the fire from below the boilers, when the hand can no longer be held in the aqueous vehicle which they contain, if the maddering be then continued for two or three hours, the most satisfactory results will be obtained, as the furnace still retains a sufficient quantity of heat to maintain the vehicle at the same temperature, especially when, according to custom, large boilers are employed. Besides, it would be very difficult to fix a determinate degree of heat by the thermometer when the furnaces are large.

The yellow parts of the madder as well as of other colouring substances are, it is probable, nothing else than the colouring parts themselves combined with oxygen. The product of this combination, by acquiring greater solubility, suffers itself with more difficulty to be taken away by clearing, if the heat has not been properly regulated during the process of dyeing. I have often observed that madder, and other colouring substances, when long exposed to the atmospheric air, do not give colours of the same intensity and the same brightness as before; either because these substances absorb the oxygen of the atmosphere, or that they procure this radical from the water which they attract, or which they naturally contain as a constituent principle, and which is decomposed by a

slow and insensible fermentation. The exposure, on the grass, of cotton or linen dyed a dark madder red, might support the idea of a change to a reddish yellow; for this dark colour becomes clearer but fainter by the exposure, and then assumes a more agreeable shade of crimson. I have shown, in a memoir on indigo, inserted in the *Journal de Physique* for the year 1788, that nitric acid changes this blue fecula into a yellowish substance: a similar change takes place by exposing, on the meadow, the same fecula fixed on any stuff whatever; and the yellow resulting in these two ways is more soluble in warm water than in the same liquid when cold. It however appears that the combination of oxygen is not the only cause of the change of colours, since curtains of any stuff dyed or coloured any shade whatever by vegetable or animal substances, and exposed to the light, lose their colour entirely in the course of time on the side exposed to the solar rays, while the opposite side retains it for a considerable time. If the rays of the sun then give more vigour to living bodies of the animal and vegetable kingdom by disengaging from the latter oxygen gas, it appears that they act with destructive influence on the same bodies deprived of life, by decomposing their constituent principles. In all cases it will be proper to preserve the colouring ingredients in dry places sheltered from the light, which acts upon these bodies perhaps only by decomposing the constituent aqueous part, the oxygen of which may join the carbon to form carbonic acid. Resinous and oily substances should be preserved in the same way. These conjectures prove at least that the action of the sun's rays, or of light, on these bodies, in general presents a vast field for interesting experiments to be undertaken.

If in maddering brighter colours are obtained by carefully regulating the heat, a sacrifice is made at the same

time of a small portion of the colouring parts of the madder, which cannot be entirely exhausted except by then increasing the heat to ebullition: but as the colours thus obtained are degraded more or less in the ratio of the quantity of the madder, the gall-nut or shumac used, this method must be employed with caution, and principally for common effects, either in regard to cotton or linen. To avoid as much as possible the loss of madder after the maddering of good articles has been terminated, and before the common ones are put into the boiler, powdered gall-nut or shumac must be added, with a new, but small portion of madder: the process must be managed also in such a manner, that the ebullition shall not take place till two hours after.

I several times tried to exhaust the madder by simple ebullition, and without adding any thing else than chalk; but I found that this was unfavourable to all colours, black excepted: it even appeared that the effect of the madder was much less than when the heat was moderately applied, and when the accumulated caloric easily decomposed the colouring substance. It is this tendency to be decomposed, and particularly by fermentation, however little it be moistened or diluted with water, which has hitherto prevented me from obtaining a substantial colour, pretty dark, and sufficiently fixed to be applied on any kind of stuff. I observed also, that if the heat was carried too far the first time, in circumstances when it was proposed to madder a second and third time, it prevented me not only from obtaining bright and agreeable shades, but also of the requisite intensity. The aqueous vehicle of the madder, at too high a temperature, never fails to weaken the adhesive force of the alumine and the oxide of iron to the stuff, and to take from it a portion, which an experienced eye may easily remark on examining the bath.

I shall here repeat, that for common and low-priced articles it is indispensably necessary to employ gall-nuts or shumac, which will save one half and even two thirds of the madder; but the colours obtained are neither so fixed nor so bright. The addition of chalk, however, must not be omitted; otherwise the gallic acid will carry away a portion of the alumine and coloured oxide of iron, which will weaken the shades, and, by tarnishing the stuffs, will also attack the white which may have been preserved in them. Without the addition of gall-nuts or shumac, it seemed to me impossible to exhaust the madder entirely of its colouring parts; which made me presume that their adhesion is favoured by the viscid nature of the tanning principle of these astringent substances, which carry away and combine with themselves the colouring parts. I shall observe also, that gall-nuts as well as shumac lose the property of dyeing black; and acquire, on the other hand, that of dyeing or colouring alumine yellow, oxide of iron olive green, by the addition of chalk, the calcareous base of which unites itself to the gallic acid. Do these yellow and olive-green colours arise from any peculiar substance contained in the gall-nuts and shumac, or are they indebted for their origin to the tanning principle? This remains to be examined.

The quantity of madder to be employed in dyeing ought not only to be proportioned to the extent of the surfaces to be maddered, but also to the concentration of the liquors of the *acetite of alumine and iron,* improperly called mordants; that is to say, to the greater or less quantity of alumine and oxide of iron which these saline liquors, either insulated or mixed together, when they dry on the articles to be dyed, may have left or deposited there by the evaporation of the acetic acid. If the objects to be dyed are not numerous, and, in particular,

when bright shades only are to be produced, they may be maddered only once; but when they are numerous, and intended to have dark shades, the maddering must be repeated twice, and even thrice. Three quarters of a pound of madder of a good quality are sufficient for dyeing a piece of white Indian cloth of ten ells in length and three quarters broad, intended to exhibit only a few coloured objects: the quantity of the colouring substance must be increased in the ratio of the mass of alumine and oxide of iron, fixed on a piece of stuff of the above dimensions. It may be extended to 6, 8, 10, and even 12 pounds, for a ground well covered with a lively and very intense colour. Intelligence and practice in the management of a dye-house will not fail to indicate nearly the proper proportions.

Whatever care may be employed in maddering to avoid the adhesion of the yellow parts, the colours obtained will be far from having all the beauty and fixity which they might acquire by clearing, preceded by very long ebullition in exceedingly pure water. This ebullition alone, by the addition of bran, will serve to brighten the colour: more rosy reds will be obtained by employing soap with or without the addition of bran; carbonate of potash or of soda, substituted for bran, will make the reds incline to crimson; but I must observe, that unless the workman chooses to run the risk of making the reds entirely brown, and in such a manner that it will not be possible to restore them, it will be necessary, before soap and alkalies are applied to the stuffs, to expose them to the action of the strongest heat that can be communicated to water. This operation will be attended with success, if as little passage as possible be afforded to the steam, and if the boilers employed be converted into a sort of digesters. The fixity of the colours will be proportioned to the time employed in exposing them

to the action of the boiling water. It is needless to observe, that there is no danger of spoiling the colours by soap and alkaline carbonates, when the maddering, instead of being directed with a moderate heat, has been carried to ebullition, as is practised in many dye-houses; but, in this case, the colours obtained are more difficult to be cleared.

As water charged with oxygenated muriatic acid easily carries away the colouring parts of madder, as well as other vegetable and animal substances, by decomposing them; and as acids more concentrated may, in their turn, take from the stuffs the colourless alumine and the oxide of iron, it is impossible for me to adopt the idea of a chemical combination of the colouring parts with alumine and metallic oxides, which, in my opinion, when fixed and coloured on any stuff, form only compound aggregates.

The clearing of objects printed on a white ground requires modifications, which I shall detail on a future occasion, when I find leisure. It will therefore be sufficient at present to state, that after continuing for some time my experiments on the Turkey red, inserted in the *Annales de Chimie* for the year 1792, I at last found a red much more beautiful and durable than that of the Levant, by fixing alumine on cotton, thread, and linen, by an alkaline solution of this earth mixed with linseed oil. The following is the process I employed.

*(To be continued.)*

## No. 19.

### *Extract from the Memoir of Messrs.* Mouchel, *of l'Aigle, in the Department de l'Orne, on the Manufacture of Iron and Steel Wire.**

This is one of the most considerable manufactories of this kind in France, and is said to produce a hundred thousand quintals of iron wire annually, in cards for wool-combing only. This is chiefly consumed in France, and exported to Spain, Portugal, Italy, and the shores of the Levant. It is necessary that the attention of the manufacturer, in the first instance, be directed to the choice of materials; and Messrs. Mouchel, after trying a great many specimens, have adopted the iron from the departments of l'Orne and Haute Saone, as being the best adapted for the purpose. The first affords the best wire for screws, nails, and pins; but, by reason of its ductility, that of the latter department can be made extremely fine, and appears to be most free from heterogeneous particles. The inconvenience of being obliged to use iron from different smelting houses, was found to be extremely prejudicial to the uniformity and perfection required in the delicate processes that are necessary in making iron wire. These manufacturers therefore established a smelting house of their own in the department of Haute Saone, whence the prepared iron is conveyed by means of rivers and canals, at a small expense, to the manufactory at l'Aigle.

When the iron has been formed into an irregular bar of about a *centimetre* (.39371 inches English) in diameter, they begin to draw it into wire. For this purpose

* Retrospect, vol. 6. p. 142. From Repertory of Arts, Nos. 95 and 96, Second Series.

they first pass it four times through the drawing plate. The fibres which appear at the utmost extension of the molecules that are arranged lengthways, are removed by heat, and the process again repeated three times. The whole operation is thus repeated five times, and consequently the wire is passed through fifteen numbers; after which a single heating is sufficient to fit it to pass through six others, and then it is reduced to the thickness of a knitting needle. Steel wire being much harder than that made of iron, requires to be passed through forty-four numbers, and to be annealed every second time. The wire is drawn with either the pincers or the bobbin, which is a cylinder adapted to axle-trees. This last was invented by the grandfather of Messrs. Mouchel, and is used to prevent the marks occasioned by the application of the pincers. The degree of heat required in annealing the wire must be regulated by the diameter; as upon this much of the perfection of the manufacture depends. When the wire is sufficiently stretched at each heating, it assumes a peculiar colour, which the workmen are careful to observe.

For annealing the wire, these manufacturers employ a large elevated furnace, in which the wire is supported in the middle of the flames on bars of cast iron. This furnace is capable of containing seven thousand pounds weight of wire, so arranged, that the thickest is exposed to the greatest heat; so that the whole becomes equally heated in the same time. An inconvenience, however, is experienced with this furnace, which leaves the heated wire exposed to the atmospheric air, which occasions both a considerable loss of oxyd, and an expense in removing it. In order to prevent this, they have invented another furnace, which is round, and about one metre six decimetres (near 5 feet 3 inches English) in diameter; and one metre eight decimetres (5 feet 10.8678

inches) in height, exclusive of its parobolic arch and chimney. The interior of this furnace is divided into three parts; the first receives the cinders; the second is the fire place; and the third receives the wire, which is placed between two cylinders, situated within each other, and made air tight. The diameter of the larger cylinder is about one metre four centimetres (near 55 inches) and that of the inner one about one metre (39.371 inches;) and the fire circulates about the exterior surface of the former, and within the latter. Several pairs of cylinders are provided, in order that they may be changed every hour, which is effected by means of a lever, that enables one man to draw them out or push them in at pleasure. These cylinders are not opened till some time after they are drawn out of the fire, which prevents the oxidation that would take place if the atmospheric air was admitted while the wire was hot. This new furnace is more expensive than that which was previously used; but its advantages more than counterbalance this expense. It is used for all wire intended for cards; and the large furnace for that of a larger and harder kind; but in order to diminish the formation of the oxyd, the bundles of wire are dipped into a quantity of wet clay, and then put into the furnace, and suffered to dry before the fire is lighted.

These authors make use of two sorts of drawing plates; large and small; in the formation of which great care is necessary, as much depends upon the ability with which this is executed. The method they employ for this purpose is to put pieces of iron of a proper size and quality, into a furnace with cast steel, and increase the heat until the latter is fused; then the iron is taken out, and the steel that adheres to it is amalgamated with it by gentle blows.

It is then permitted to cool, and the same process re-

peated several times, till the plate has acquired its proper form and hardness. It is necessary that these plates should be of considerable thickness; and the smallest used by Messrs. Mouchel are at least two centimetres (.78742 inches) in thickness. After the wire has undergone the last operation in the workshop of the wire drawer, and is reduced to the required degree of fineness, the smallest of which is stated at 100,000 metres in length to a chiliogram; or 109,366$\frac{2}{3}$ yards to 2lb. 3oz. 5dr. avoirdupois, by means of the bobbin, it is subjected to the process of dressage or straightening, which is esteemed the most difficult and delicate of all the operations. By this it loses the bend or curve it had acquired on the bobbins. For the more readily and effectually performing this part of the manufacture, these authors have also invented apparatus for both straightening the wire, and determining its suppleness. But for a particular description of these, with other particulars, and a table of the prices of the different sorts and sizes of wire, we must refer to the Numbers of the Repertory of Arts, mentioned at the head of this article, and the plate by which the memoir is accompanied.

## *Observations by the Editors of the Retrospect.*

Those persons who are either engaged or interested in manufactures of this nature, we conceive would be amply repaid for their trouble of perusing this memoir. It will be found to combine a much greater degree of scientific ingenuity and practical experience than are usually met with in similar essays, and the success with which these have been exerted may easily be inferred from the fineness of the wire produced. From the above statement it appears that a pound avoirdupois of the smallest wire contains about 49,553 yards in length. Now, ad-

mitting the specific gravity of this wire to be 7788, and a pound will contain $\frac{2304}{649}$ cubic inches. Therefore $\frac{2304}{649} \times \frac{1}{49553 \times 36} = \frac{64}{32159897} = .00000199316$ inches for the area of its section, and consequently, .0091593 for its diameter.

Another circumstance which confirms our opinion relative to the formation of the drawing plates, is, that one of these large plates reduces 1400 chiliograms, from the largest size to that of No. 6, which is about the thickness of a knitting needle; and 400 chiliograms are also reduced from this size to the smallest carding wire, by being passed twelve times successively through a single small plate. This we apprehend could not take place, unless they were very perfect.

[The Editor will esteem it a favour, if any person possessing the above mentioned numbers, would allow him the opportunity of giving this paper more fully than is here done, and of obtaining an engraving of the plate.]

## No. 20.

### *Method of preparing Ox-Gall in a concentrated state for Painters, and for other Uses. By* Richard Cathery.*

Sir,

It has been long a desideratum to find out a method of preparing ox-gall for the use of painters, so as to avoid the disagreeable smell, which it contracts by keeping in a liquid state, and at the same time to preserve its useful properties. I have invented a method of doing it

* Nicholson, vol. 30. p. 154. From Trans. of Soc. of Arts, vol. 28. p. 106. Ten guineas were voted to Mr. Cathery for this invention.

with very little expense, which will be a great saving to those who use gall, as it will prevent it from putrifying, or breeding maggots.

One gall prepared in my method will serve an artist a long time, as it will keep a great number of years. It will be a convenient article for use, as a small cup of it may be placed in the same box which contains other colours, where it will be always ready. The qualities of gall are well known to artists in water-colours, particularly to those who colour prints, as many colours will not, without gall, work free on such paper, on account of the oil that is used in the printing-ink.

The artists who make drawings in water-colours also use gall in the water which they mix their colour with, as it clears away that greasiness, which arises from moist hands upon paper, and makes the colour work clear and bright. My preparation is ready for use in a few minutes, all that is necessary being to dissolve about the size of a pea of it in a table-spoonful of water.

It is also of great use to housekeepers, sailors, and others, to clean woollen clothes from grease, tar, &c.; and will be found advantageous for many other purposes.

If it should meet with the approbation of the Society, I have no objection to prepare it for sale.

I am Sir, your obedient servant,

RICHARD CATHERY,

Botanical Colourer.

*Process for preparing Ox-Gall in a concentrated state, by Mr. Cathery.*

Take a gall fresh from the ox, and put it into a basin, let it stand all night to settle, then pour it off from the sediment into a clean earthen mug, and set it in a saucepan of boiling water over the fire, taking care that none of the water gets into the mug. Let it boil till it is quite

thick, then take it out and spread it on a plate or dish, and set it before the fire to evaporate; and when as dry as you can get it, put it into small pots, and tie papers over their tops to keep the dust from it, and it will be good for years.

Certificates were received from Mr. Gabriel Bayfield, No. 9, Park Place, Walworth, and Mr. William Edwards, No. 9, Poplar Row, both botanical colourers, stating, that they have used the ox-gall prepared by Mr. Cathery, and find it to answer better than gall in a liquid state; that this preparation is free from disagreeable smell, and is much cheaper, as one ox-gall thus prepared will last one person for two years, and be as fresh as if just taken from the ox.

A Certificate was received from Mr. James Stewart, No. 26, St. Martin's Street, Leicester Square, stating, that he lately belonged to his Majesty's ship the Vestal frigate, and that he took out with him, in a voyage to Newfoundland, a large pot of the prepared ox-gall, for the purpose of washing his greasy clothes for two years; that he found it very serviceable, and to keep its virtue as well as the first day.

## No. 21.

*Experiments on the Growth of White Thorn, pointing out a better Method of propagating that valuable Plant than had before been practised. By* Samuel Taylor, *Esq. of Moston, near Manchester.**

For these experiments the silver medal of the Society for the Encouragement of Arts, &c. was voted to Mr. Taylor, from whom the following accounts were received. Specimens of the plants are reserved in the repository of the society, where they may be seen by agriculturists.

* Tilloch, vol. 25. p. 39. From Trans. of the Society of Arts, &c. 1805.

Gentlemen,

Every one of you, I think, will allow that fences are material objects to be attended to in agriculture; you must also be convinced that there is no plant in this kingdom of which they can so properly be made as the Cratægus oxyacantha Linnæi, or common White Thorn. In consequence of my being convinced of this, I have been induced to make a few experiments to effect the better propagation of that valuable plant; the result of which, along with specimens of my success, I beg leave to submit to your inspection.

In the year 1801, I had occasion to purchase a quantity of thorns, and finding them very dear, I was determined to try some experiments, in order if possible to raise them at a less expense. I tried to propagate them from cuttings of the branches, but with little or no success. I likewise tried if pieces of the root would grow; and I cut from the thorns which I had purchased about a dozen of such roots as pleased me, and planted them in a border along with those I had bought. To my great astonishment, not one of them died; and in two years they became as good thorns as the average of those I had purchased. The thorns I purchased were three years old when I got them. In April, 1802, I had occasion to move a fence, from which I procured as many roots of thorns as made me upwards of two thousand cuttings, of which I did not lose five in the hundred.

In the spring of 1803, I likewise planted as many cuttings of thorn roots as I could get. In 1804, I did the same; and this year I shall plant many thousands.

I have sent for your inspection specimens of the produce of 1802, 1803, and 1804, raised after my method, with the best I could get of those raised from haws in the common way, which generally lie one year in the ground before they vegetate. They are all exactly one,

two, and three years old, from the day they were planted.—I was so pleased with my success in raising so valuable an article to the farming interest of this kingdom, at so trifling an expense, (for it is merely that of cutting the roots into lengths and planting them,) that I was determined to make it known to the world, and could think of no better method than communicating it to your society; and should you so far approve of this method of raising thorns, as to think me entitled to any honorary reward, I shall receive it with gratitude, but shall feel myself amply repaid for any trouble I have been at, should you think it worthy a place in the next volume of your Transactions.

The method of raising the thorns from roots of the plant, is as follows.

I would advise every farmer to purchase a hundred or a thousand thorns, according to the size of his farm, and plant them in his orchard or garden, and when they have attained the thickness of my three year old specimens, which is the size I always prefer for planting in fences, let him take them up and prune the roots in the manner I have pruned the specimen sent you, from which he will upon an average get ten or twelve cuttings from each plant, which is as good as thorns of the same thickness; so that you will easily perceive that in three years he will have a succession of plants fit for use, which he may if he pleases increase tenfold every time he takes them up.

The spring (say in all April) is the best time to plant the cuttings, which must be done in rows half a yard asunder, and about four inches from each other in the row; they ought to be about four inches long, and planted with the top one-fourth of an inch out of the ground, and well fastened; otherwise they will not succeed so well.

The reason why I prefer spring to autumn for planting the roots, is, that were they to be planted in autumn, they would not have got sufficient hold of the ground before the frost set in, which would raise them all from the ground; and, if not entirely destroy the plants, would oblige the farmer to plant them afresh.

I have attached the produce of my three-year-old specimen to the plants it came from, cut in the way I always practise; on the thick end of the root I make two, and on the other end one cut, by which means the proper end to be planted uppermost, which is the thick one, may easily be known.

Although I recommend the roots to be planted in April, yet the farmer may, where he pleases, take up the thorns he may want, and put the roots he has pruned off into sand or mould, where they will keep until he has leisure to cut them into proper lengths for planting; he will likewise keep them in the same way until planted.

The great advantage of my plan is: first, that in case any one has raised from haws a thorn with remarkably large prickles, of vigorous growth, or possessing any other qualification requisite to make a good fence, he may propagate it far better and sooner, from roots, than any other way. Secondly, in three years he may raise from roots a better plant than can in six years be raised from haws, and with double the quantity of roots; my three-year-old specimen would have been half as big again, had I not been obliged to move all my cuttings the second year after they were planted.

It would not be a bad way, in order to get roots, to plant a hedge in any convenient place, and on each side trench the ground two yards wide, and two grafts deep; from which, every two or three years, a large quantity of roots might be obtained, by trenching the ground over again, and cutting away what roots were found, which

would all be young and of a proper thickness. I do not like them of a larger size than the specimens sent.

I am at present engaged in several experiments, to endeavour to propagate the thorn from the branches, which, if successful, I will communicate to you; but I am of opinion, that what is now done is sufficient.

Should the society require any further explanations, I shall be happy in doing my utmost to furnish such explanations.

SAMUEL TAYLOR.

Moston, near Manchester,
May 6th, 1805.

*To the Society of Arts, &c.*

## No. 22.

### *List of American Patents.**

(Continued from page 80.)

1792.

Benjamin Folger, January 2, cleansing whale oil.

Obadiah Herbert, January 28, spinning and twisting thread.

John Bailey, February 23, Steam Jack.

David Hartley, February 24, hardening and tempering steel.

David Ridgeway, March 7, improvement in making bricks.

Samuel Green, March 28, canvass conductor to be used when houses are on fire.

Timothy Kirk and Robert Leslie, May 9, weaving of wire.

Thomas Farrington, May 9, Machine for sawing wood and bark.

George Morris, July 10, preservation of plants from frost, &c.

Samuel G. Dorr, October 20, Machine called "the wheel of knives," for shearing and raising the nap on cloths.

Sol. Hodge and J. Dorr, Oct. 23, Handmill for picking millstones.

1793.

James Caldwell and Christopher Batterman, Jan. 26, improved machine for manufacturing tobacco.

Joseph Pope, January 26, improvement in wind mills.

* Nicholson, vol. 12. p. 220.

Christopher Colles, January 26, manufacturing bricks.
Samuel Morey, January 29, improved mode of turning a spit.
Robert Leslie, January 30, double pendulum for ships.
Robert Leslie, January 30, clock pendulum.
Robert Leslie, January 30, double pendulum.
Ralph Hodgson, Feb. 1, manufacturing oiled silk and linen, &c.
Apollos Kinsley, Feb. 1, improvement in making bricks.
Robert Leslie, Feb. 2, construction and tone of bells.
Rich. Rosewel Saltonstall, Feb. 28, manufacturing rhus or sumach.
John Carnes, jun. April 11, improvement in paper moulds.
Edward Ryan, April 29, furnace for pot and pearl ashes.
Jonathan Williams, jun. March 13, moulds for claying sugar.
Rich. R. Saltonstall, May 1, manufacturing rhus or sumach.
Robert Heterick, June 11, stove of cast iron.
Joseph Stacey Sampson, July 5, applying and regulating the sails of ships, boats, &c.
Samuel Brouwer, Aug. 17, manufacturing brick and pantile.
Abijah Babcock, Dec. 2, machine for propelling vessels, &c.
John Clarke, Daniel Stansbury, Apollos Kinsley, John Clarke, Dec. 31, disputed claim for a machine to work in a current of water, &c. decided in favour of.

1794.

Thomas Perkins, Feb. 7, manufacturing nails.
James Davenport, Feb. 24, weaving and beating sail duck.
J. Simpson, March 4, improvement in distilling spirituous liquors.
Zachariah Cox, March 14, round saw.
Eli Whitney, March 14, machine for ginning cotton.
B. Taylor, March 23, mode of preventing the progress of fire.
J. Biddis, March 31, improvement in manufacturing paper, &c.
R. Robotham, April 12, composition for flooring houses, &c.
John J. Staples, April 25, improvement in carriages, to be propelled by the mechanical powers.
William Hodgson, April 28, machine for threshing grain, &c.
James Drake, May 9, construction of bellows.
Richard Robotham, June 2, manufacturing of candles.
George Parkinson, June 16, Manufacturing cordage.
John Markley, July 19, new mode of grinding bark.
Elisha Rigg, July 29, improvement in the method of working pumps.
Alexander Anderson, Sept. 2, improvement in a steam still.
Benjamin Wynkoop, Sept. 13, new mode of propelling vessels.

James Fennel, Sept. 24, mode of making salt.
Joshua Hatheway, Oct. 29, improvement in hydraulics.
J. Wardrop, Nov. 5, improvement in a threshing machine.
John Kincaid, Nov. 25, improvement in stills.
Apollos Kinsley, Dec. 20, tempering mortar and making bricks.

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*List of English Patents.**

1796.

Michael Bowman, March 1; for a truss for the prevention and cure of ruptures.

Lord William Murray, March 8; for the invention and discovery of extracting starch from horse-chesnuts.

John Atkinson, March 8; for the application of certain materials to make white paint.

Robertson Buchanan, March 8; for a pump for raising water in various situations.

Robert Salmon, March 8; for an improvement in certain machines for weighing goods, &c.

Major Pratt, March 11; for a certain composition to answer the purpose of mill-stones.

William Woods, March 17; for a hand-pump for raising water out of ships, and other places, by which a greater quantity of water can be raised in less time than by any other pump now in use.

Richard Varley, March 17; for an improved method of carding, roving, and spinning cotton, wool, &c.

John Gregory Hancock, April 6; for paper ornamented by embossing and enchasing.

Samuel Godfrey, April 6; for a machine to relieve the labour of animals, in draft or burden.

William Moorcroft, April 16; for an improved and expeditious method of making horse-shoes, &c.

Patrick Miller, May 3; for the invention of a vessel on a new construction, which draws less water than any other vessel of the same dimensions, which cannot founder at sea, and which is put in motion, in calms and light winds, by a method never before pratised.

*(To be continued.)*

* Repert. vol. 6.

## INTELLIGENCE.

### *Spent Oil of the Curriers.**

The process by which the curriers impregnate their skins is by smearing the oil upon the wet skin, into which it penetrates as the moisture evaporates. A pure oil could not perhaps be thus spread, and most probably would not enter the skin with the desired effect, or render it as supple as that oil which from experience they are led to prefer.

The celebrated Seguin has directed his attention to this ingredient of such extensive manufacturing utility. He remarks, that this material (by the name of *Degras*) is of two kinds in France; *viz.* the common sort and that of Niort. The first is the immediate product of the chamoying of skins, which are cleared of their surplus oil by solution of potash. It therefore contains not only soap, but likewise gelatine. It is evaporated to dryness, and then sold as *Degras*. At Niort it is decomposed by sulphuric acid, and the precipitate is called the *Degras* of that town.

Mr. Seguin finds by analysis, that this last is oxigenated oil, whereas the other is a compound of soap and gelatine. He succeeded in giving to whale oil all the properties of the *Degras* of Niort, by boiling one pound for a few minutes with half an ounce of nitric acid at 25 degrees. He observed that no gas is disengaged in this operation; but that water and nitrate of ammonia are formed; and he concludes that the oil was oxigenated, not by absorbing the oxigen of the acid, but by yielding to it part of the hydrogen which was one of its own component parts. The result is the more interesting, as the *Degras* of Niort being much more esteemed than the common sort, the curriers may hereafter, instead of paying a great price for it, make it in as large quantities as they please by following the process here indicated.

* Nich. Ph. Mag. vol. 12. p. 220.

*Benjamin Franklin*

*Born Jan^y 17^th 1706 Died April 17^th 1790.*

THE

# EMPORIUM

OF

# ARTS AND SCIENCES.

VOL. 1.] JULY, 1812. [NO. 3.

## No. 24.

## ON SPONTANEOUS COMBUSTION.

(Continued from page 104.)

### *On the Combustion of the Human Body, produced by the long and immoderate use of Spirituous Liquors. By* PIERRE-AIME LAIR.*

IN natural as well as civil history there are facts presented to the meditation of the observer, which, though confirmed by the most convincing testimony, seem on the first view to be destitute of probability. Of this kind is that of people consumed by coming into contact with common fire, and of their bodies being reduced to ashes. How can we conceive that fire, in certain circumstances, can exercise so powerful an action on the human body as to produce this effect? One might be induced to give less faith to these instances of combustion, as they seem to be rare. I confess that at first they appeared to me worthy of very little credit, but they are presented to the public as true by men whose veracity seems unquestion-

* Tilloch, vol. 6. p. 132. From the Journal de Physique, Pluviose, year 8.

able. Bianchini, Maffei, Rolli, Le Cat, Vicq-d'Azyr, and several men distinguished by their learning, have given certain testimony of the facts. Besides, is it more surprising to experience such incineration than to void saccharine urine, or to see the bones softened to such a degree as to be reduced to the state of a jelly? The effects of this combustion are certainly not more wonderful than those of the bones softened, or of the diabetes mellitus. This morbific disposition, therefore, would be one more scourge to afflict humanity; but in physics, facts being always preferable to reasoning, I shall here collect those which appear to me to bear the impression of truth; and, lest I should alter the sense, I shall quote them such as they are given in the works from which I have extracted them.

We read in the Transactions of Copenhagen, that in 1692 a woman of the lower class, who for three years had used spirituous liquors to such excess that she would take no other nourishment, having sat down one evening on a straw chair to sleep, was consumed in the night-time, so that next morning no part of her was found but the skull and the extreme joints of the fingers; all the rest of her body, says Jacobæus, was reduced to ashes.

The following extract of the memoir of Bianchini is taken from the Annual Register for 1763:—The Countess Cornelia Bandi, of the town of Cesena, aged 62, enjoyed a good state of health. One evening, having experienced a sort of drowsiness, she retired to bed, and her maid remained with her till she fell asleep. Next morning, when the girl entered to awaken her mistress, she found nothing but the remains of her body in the most horrid condition. At the distance of four feet from the bed was a heap of ashes, in which could be distinguished the legs and arms untouched. Between the legs lay the head, the brain of which, together with half the

posterior part of the cranium, and the whole chin, had been consumed: three fingers were found in the state of a coal; the rest of the body was reduced to ashes, which, when touched, left on the fingers a fat, fœtid moisture. A small lamp which stood on the floor was covered with ashes, and contained no oil; the tallow of two candles was melted on a table, but the wicks still remained, and the feet of the candlesticks were covered with a certain moisture. The bed was not damaged; the bed-clothes and coverlid were raised up and thrown on one side, as is the case when a person gets up. The furniture and tapestry were covered with a moist kind of soot of the colour of ashes, which had penetrated into the drawers and dirtied the linen. The soot having been conveyed to a neighbouring kitchen, adhered to the walls and the utensils. A piece of bread in the cupboard was covered with it, and no dog would touch it. The infectious odour had been communicated to other apartments. The Annual Register states, that the Countess of Cesena was accustomed to bathe all her body in camphorated spirit of wine. Bianchini caused the details of this deplorable event to be published at the time when it took place, and no one contradicted them. It was attested also by Scipio Maffei, a learned cotemporary of Bianchini, who was far from being credulous; and, in the last place, this surprising fact was confirmed to the Royal Society of London by Paul Rolli. The Annual Register mentions also two other facts of the same kind which occurred in England, one at Southampton, and the other at Coventry.

An instance of the like kind is preserved in the same work * in a letter to Mr. Wilmer, surgeon:—" Mary Clues, aged 50, was much addicted to intoxication. Her

* Annual Register for 1773, p. 78.

propensity to this vice had increased after the death of her husband, which happened a year and a half before. For about a year, scarcely a day had passed in the course of which she did not drink at least half a pint of rum or aniseed-water. Her health gradually declined, and about the beginning of February she was attacked by the jaundice and confined to her bed. Though she was incapable of much action, and not in a condition to work, she still continued her old habit of drinking every day and smoking a pipe of tobacco. The bed in which she lay stood parallel to the chimney of the apartment, and at the distance from it of about three feet. On Saturday morning, the 1st of March, she fell on the floor; and her extreme weakness having prevented her from getting up, she remained in that state till some one entered and put her to bed. The following night she wished to be left alone. A woman quitted her at half after eleven, and, according to custom, shut the door and locked it. She had put on the fire two large pieces of coal, and placed a light in a candlestick on a chair at the head of her bed. At half after five in the morning a smoke was seen issuing through the window, and the door being speedily broke open, some flames which were in the room were soon extinguished. Between the bed and the chimney were found the remains of the unfortunate Clues: one leg and a thigh were still entire; but there remained nothing of the skin, the muscles, and the viscera. The bones of the cranium, the breast, the spine, and the upper extremities, were entirely calcined, and covered with a whitish efflorescence. The people were much surprised that the furniture had sustained so little injury. The side of the bed which was next to the chimney had suffered the most; the wood of it was slightly burnt; but the feather-bed, the clothes, and covering, were safe. I entered the apartment about two hours after it had been open-

ed, and observed that the walls and every thing in it were blackened; that it was filled with a very disagreeable vapour; but that nothing except the body exhibited any strong traces of fire."

This instance has great similarity to that related by Vicq-d'Azyr in the *Encyclopédie Methodique,* under the head, Pathologic Anatomy of Man. A woman, about fifty years of age, who indulged to excess in spirituous liquors, and got drunk every day before she went to bed, was found entirely burnt, and reduced to ashes. Some of the osseous parts only were left, but the furniture of the apartment had suffered very little damage. Vicq-d'Azyr, instead of disbelieving this phenomenon, adds, that there have been other instances of the like kind.

We find also a circumstance of this kind in a work entitled, *Acta Medica et philosophica Hafniensia;* and in the work of Henry Bohanser, entitled, *Le nouveau phosphore enflammé.* A woman at Paris, who had been accustomed, for three years, to drink spirit of wine to such a degree that she used no other liquor, was one day found entirely reduced to ashes, except the skull and extremities of the fingers.

The Transactions of the Royal Society of London present also an instance of human combustion no less extraordinary: It was mentioned at the time it happened in all the journals; it was then attested by a great number of eye-witnesses, and became the subject of many learned discussions. Three accounts of this event, by different authors, all nearly coincide. The fact is related as follows:—" Grace Pitt, the wife of a fishmonger of the parish of St. Clement, Ipswich, aged about sixty, had contracted a habit, which she continued for several years, of coming down every night from her bedroom, half dressed, to smoke a pipe. On the night of the 9th of April, 1744, she got up from bed as usual.

Her daughter, who slept with her, did not perceive she was absent till next morning when she awoke, soon after which she put on her clothes, and going down to the kitchen, found her mother stretched out on the right side, with her head near the grate; the body extended on the hearth, with the legs on the floor, which was of deal, having the appearance of a log of wood, consumed by a fire without apparent flame. On beholding this spectacle, the girl ran in great haste and poured over her mother's body some water contained in two large vessels in order to extinguish the fire; while the fœtid odour and smoke which exhaled from the body almost suffocated some of the neighbours who had hastened to the girl's assistance. The trunk was in some measure incinerated, and resembled a heap of coals covered with white ashes. The head, the arms, the legs, and the thighs, had also participated in the burning. This woman, it is said, had drunk a large quantity of spirituous liquor in consequence of being overjoyed to hear that one of her daughters had returned from Gibraltar. There was no fire in the grate, and the candle had burnt entirely out in the socket of the candlestick, which was close to her. Besides, there were found near the consumed body the clothes of a child and a paper screen, which had sustained no injury by the fire. The dress of this woman consisted of a cotton gown.

Le Cat, in a memoir on spontaneous burning, mentions several other instances of combustion of the human body. "Having," says he, "spent several months at Rheims in the years 1724 and 1725, I lodged at the house of Sieur Millet, whose wife got intoxicated every day. The domestic economy of the family was managed by a pretty young girl, which I must not omit to remark, in order that all the circumstances which accompanied the fact I am about to relate, may be better understood. This

woman was found consumed on the 20th of February, 1725, at the distance of a foot and a half from the hearth in her kitchen. A part of the head only, with a portion of the lower extremities and a few of the vertebræ, had escaped combustion. A foot and a half of the flooring under the body had been consumed, but a kneading-trough and a powdering-tub, which were very near the body, had sustained no injury. M. Chretien, a surgeon, examined the remains of the body with every juridical formality. Jean Millet, the husband, being interrogated by the judges who instituted an inquiry into the affair, declared, that about eight in the evening on the 19th of February he had retired to rest with his wife, who, not being able to sleep, had gone into the kitchen, where he thought she was warming herself; that, having fallen asleep, he was wakened about two o'clock by an infectious odour, and that, having run to the kitchen, he found the remains of his wife in the state described in the report of the physicians and surgeons. The judges having no suspicion of the real cause of this event, prosecuted the affair with the utmost diligence. It was very unfortunate for Millet that he had a handsome servant-maid, for neither his probity nor innocence was able to save him from the suspicion of having got rid of his wife by a concerted plot, and of having arranged the rest of the circumstance in such a manner as to give it the appearance of an accident. He experienced, therefore, the whole severity of the law; and though, by an appeal to a superior and very enlightened court, which discovered the cause of the combustion, he came off victorious, he suffered so much from uneasiness of mind, that he was obliged to pass the remainder of his melancholy days in an hospital."

Le Cat relates another instance, which has a most perfect resemblance to the preceding:—" M. Boinneau, curé

of Plerguer, near Dol," says he, "wrote to me the following letter, dated February 22, 1749: Allow me to communicate to you a fact which took place here about a fortnight ago. Madame de Boiseon, 80 years of age, exceedingly meagre, who had drunk nothing but spirits for several years, was sitting in her elbow-chair before the fire while her waiting-maid went out of the room for a few moments. On her return, seeing her mistress on fire, she immediately gave an alarm, and some people having come to her assistance, one of them endeavoured to extinguish the flames with his hand, but they adhered to it as if it had been dipped in brandy or oil on fire. Water was brought and thrown on the lady in abundance, yet the fire appeared more violent, and was not extinguished till the whole flesh had been consumed. Her skeleton, exceedingly black, remained entire in the chair, which was only a little scorched; one leg only, and the two hands, detached themselves from the rest of the bones. It is not known whether her clothes had caught fire by approaching the grate. The lady was in the same place in which she sat every day; there was no extraorninary fire, and she had not fallen. What makes me suspect that the use of spirits might have produced this effect is, that I have been assured, that at the gate of Dinan an accident of the like kind happened to another woman under similar circumstances."

To these instances, which I have multiplied to strengthen the evidence, I shall add two other facts of the same kind, published in the *Journal de Medicine*.* The first took place at Aix, in Provence, and is thus related by Muraire, a surgeon:—"In the month of February, 1779, Mary Jauffret, widow of Nicholas Gravier, shoemaker, of a small size, exceedingly corpulent,

* Vol. 59. p. 440.

and addicted to drinking, having been burnt in her apartment, M. Rocas, my colleague, who was commissioned to make a report respecting the remains of her body, found only a mass of ashes, and a few bones, calcined in such a manner that on the least pressure they were reduced to dust. The bones of the cranium, one hand, and a foot, had in part escaped the action of the fire. Near these remains stood a table untouched, and under the table a small wooden stove, the grating of which, having been long burnt, afforded an aperture, through which, it is probable, the fire that occasioned the melancholy accident had been communicated: one chair, which stood too near the flames, had the seat and forefeet burnt. In other respects, there was no appearance of fire either in the chimney or the apartment; so that, except the fore-part of the chair, it appears to me that no other combustible matter contributed to this speedy incineration, which was effected in the space of seven or eight hours."

The other instance, mentioned in the *Journal de Medicine*,* took place at Caen, and is thus related by Merille, a surgeon of that city, still alive:—"Being requested, on the 3d of June, 1782, by the king's officers, to draw up a report of the state in which I found Mademoiselle Thuars, who was said to have been burnt, I made the following observations:—The body lay with the crown of the head resting against one of the andirons, at the distance of eighteen inches from the fire; the remainder of the body was placed obliquely before the chimney, the whole being nothing but a mass of ashes. Even the most solid bones had lost their form and consistence; none of them could be distinguished except the coronal, the two parietal bones, the two lumbar ver-

* Vol. 59. p. 140.

tebræ, a portion of the tibia, and a part of the omoplate; and these, even, were so calcined, that they became dust by the least pressure. The right foot was found entire, and scorched at its upper junction; the left was more burnt. The day had been cold, but there was nothing in the grate except two or three bits of wood, about an inch in diameter, burnt in the middle. None of the furniture in the apartment was damaged. The chair on which Mademoiselle Thuars had been sitting, was found at the distance of a foot from her, and absolutely untouched. I must here observe, that this lady was exceedingly corpulent; that she was above sixty years of age, and much addicted to spirituous liquors; that the day even of her death she had drunk three bottles of wine and about a bottle of brandy; and that the consumption of the body had taken place in less than seven hours, though, according to appearance, nothing around the body was burnt but the clothes."

The town of Caen affords several other instances of the same kind. I have been told by many people, and particularly a physician of Argentan, named Bouffet, author of an Essay on Intermittent Fevers, that a woman of the lower class, who lived at *Place Villars,* and who was known to be much addicted to strong liquor, had been found in her house burnt. The extremities of her body only were spared, but the furniture was very little damaged.

A like unfortunate accident happened also at Caen to another old woman addicted to drinking. I was assured by those who told me the fact, that the flames which proceeded from the body could not be extinguished by water; but I think it needless to relate the particulars of this and of another similar event which took place in the same town, because, as they were not attested by a *pro-*

*ces-verbal,* and not having been communicated by professional men, they do not inspire the same confidence.

This collection of instances is supported, therefore, by all those authentic proofs which can be required to form human testimony; for, while we admit the prudent doubt of Descartes, we ought to reject the universal doubt of the Pyrrhonists. The multiplicity and uniformity even of these facts, which occurred in different places, and were attested by so many enlightened men, carry with them conviction; they have such a relation to each other, that we are inclined to ascribe them to the same cause.

1. The persons who experienced the effects of this combustion had for a long time made an immoderate use of spirituous liquors.

2. The combustion took place only in women.

3. These women were far advanced in life.

4. Their bodies did not take fire spontaneously, but were burnt by accident.

5. The extremities, such as the feet and the hands, were generally spared by the fire.

6. Water sometimes, instead of extinguishing the flames which proceeded from the parts on fire, gave them more activity.

7. The fire did very little damage, and often even spared the combustible objects which were in contact with the human body at the moment when it was burning.

8. The combustion of these bodies left as a residuum fat fœtid ashes, with an unctuous, stinking, and very penetrating soot.

Let us now enter into an examination of these eight general observations.

The first idea which occurs on reading the numerous instances of human combustion above related is, that those who fell victims to those fatal accidents were al-

most all addicted to spirituous liquors. The woman mentioned in the Transactions of Copenhagen had for three years made such an immoderate use of them, that she would take no other nourishment. Mary Clues, for a year before the accident happened, had scarcely been a single day without drinking half a pint of rum or of aniseed-water. The wife of Millet had been continually intoxicated; Madame de Boiseon for several years had drunk nothing but spirits; Mary Jauffret was much addicted to drinking; and Mademoiselle Thuars, and the other women of Caen, were equally fond of strong liquors.

Such excess, in regard to the use of spirituous liquors, must have had a powerful action on the bodies of the persons to whom I allude. All their fluids and solids must have experienced its fatal influence; for the property of the absorbing vessels, which is so active in the human body, seems on this occasion to have acted a distinguished part. It has been observed that the urine of great drinkers is generally aqueous and limpid. It appears, that in drunkards who make an immoderate use of spirituous liquors, the aqueous part of their drink is discharged by the urinary passage, while the alcoholic, almost like the volatile part of aromatic substances, not being subjected to an entire decomposition, is absorbed into every part of their bodies.

I shall now proceed to the second general observation, that the combustion took place only in women.

I will not pretend to assert that men are not liable to combustion in the same manner, but I have never yet been able to find one well certified instance of such an event; and as we cannot proceed with any certainty but on the authority of facts, I think this singularity so surprising as to give rise to a few reflections. Perhaps when the cause is examined, it will appear perfectly na-

tural. The female body is in general more delicate than that of the other sex. The system of their solids is more relaxed; their fibres are more fragile and of a weaker structure, and therefore their texture more easily hurt. Their mode of life also contributes to increase the weakness of their organization. Women, abandoned in general to a sedentary life, charged with the care of the internal domestic economy, and often shut up in close apartments, where they are condemned to spend whole days without taking any exercise, are more subject than men to become corpulent. The texture of the soft parts in female bodies being more spongy, absorption ought to be freer; and as their whole bodies imbibe spirituous liquors with more ease, they ought to experience more readily the impression of fire. Hence that combustion, the melancholy instances of which seem to be furnished by women alone; and it is owing merely to the want of a certain concurrence of circumstances and of physical causes, that these events, though less rare than is supposed, do not become more common.

The second general observation serves to explain the third; I mean, that the combustion took place only in women far advanced in life. The Countess of Cesena was sixty-two years of age; Mary Clues, fifty-two; Grace Pitt, sixty; Madame de Boiseon, eighty; and Mademoiselle Thuars more than sixty. These examples prove that combustion is more frequent among old women. Young persons, distracted by other passions, are not much addicted to drinking; but when love, departing along with youth, leaves a vacuum in the mind, if its place be not supplied by ambition or interest, a taste for gaming, or religious fervor, it generally falls a prey to intoxication. This passion still increases as the others diminish, especially in women, who can indulge it without restraint. Wilmer, therefore, observes, "that

the propensity of Mary Clues to this vice had always increased after the death of her husband, which happened about a year before:" almost all the other women of whom I have spoken, being equally unconfined in regard to their actions, could gratify their attachment to spirituous liquors without opposition.

It may have been observed that the obesity of women, as they advance in life, renders them more sedentary; and if, as has been remarked by Baumes,* a sedentary life overcharges the body with hydrogen, this effect must be still more sensible among old women. Dancing and walking, which form salutary recreation for young persons, are at a certain age interdicted as much by nature as by prejudice. It needs therefore excite no astonishment that old women, who are in general more corpulent and more addicted to drinking, and who are often motionless like inanimate masses, during the moment of intoxication, should experience the effects of combustion.

Perhaps we have no occasion to go very far to search for the cause of these combustions. The fire of the wooden stove, the chimney, or of the candle, might have been communicated to the clothes, and might have in this manner burnt the persons above mentioned, on account of the peculiar disposition of their bodies. Maffei observes, that the Countess of Cesena was accustomed to bathe her whole body with spirit of wine. The vicinity of the candle and lamp, which were found near the remains of her body, occasioned, without doubt, the combustion. This accident reminds us of that which happened to Charles II. king of Navarre. This prince, being addicted to drunkenness and excesses of every kind, had caused himself to be wrapped up in cloths dipped in spirits, in order to revive the natural heat of his body,

* Essai du Systême Chemique de la Science de l'Homme.

which had been weakened by debauchery; but the cloths caught fire while his attendants were fastening them, and he perished a victim to his imprudence.

Besides accidental combustion, it remains for us to examine whether spontaneous combustion of the human body can take place, as asserted by Le Cat. Spontaneous combustion is the burning of the human body without the contact of any substance in a state of ignition. Nature, indeed, affords several instances of spontaneous combustion in the mineral and vegetable kingdoms. The decomposition of pyrites, and the subterranean processes which are carried on in volcanoes, afford proofs of it. Coal-mines may readily take fire spontaneously; and this has been found to be the case with heaps of coals deposited in close places. It is by a fermentation of this kind that dunghills sometimes become hot, and take fire. This may serve also to explain why trusses of hay, carried home during moist weather, and piled up on each other, sometimes take fire. But, can spontaneous combustion take place in the human body? If some authors are to be credited,* very violent combustion may be produced in our bodies by nature and by artificial processes. Sturmius † says, that in the northern countries flames often burst from the stomach of persons in a state of intoxication. Three noblemen of Courland having laid a bet which of them could drink most spirits, two of them died in consequence of suffocation by the flames which issued with great violence from their stomachs. We are told by Thomas Bartholin,‡ on the authority of Vorstius, that a soldier, who had drunk two glasses of spirits, died after an eruption of flames from his mouth. In his third century Bertholin mentions another accident of the same kind after a drinking-match of strong liquor.

* German Ephemerides, Observ. 77. † Ibid. Tenth year, p. 55.
‡ First century.

It now remains to decide, from these instances, respecting the accidental or spontaneous causes which produce combustion. Nature, by assuming a thousand different forms, seems at first as if desirous to elude our observation; but, on mature, reflection, if it be found easy to prove accidental combustion, spontaneous combustion appears altogether improbable; for, even admitting the instances of people suffocated by flames which issued from their mouths, this is still far from the combustion of the whole body. There is a great difference between this semi-combustion and spontaneous combustion so complete as to reduce the body to ashes, as in the cases above mentioned. As the human body has never been seen to experience total combustion, these assertions seem rather the production of a fervid imagination than of real observation; and it too often happens that Nature in her mode of action does not adopt our manner of seeing.

I shall not extend further these observations on the combustion of the human body, as I flatter myself that after this examination every person must be struck with the relation which exists between the cause of this phænomenon and the effects that ensue. A system embellished with imaginary charms is often seducing, but it never presents a perfect whole. We have seen facts justify reasoning, and reasoning serve afterwards to explain facts. The combustion of the human body, which on the first view appears to have in it something of the marvellous, when explained, exhibits nothing but the utmost simplicity: so true it is, that the wonderful is often produced by effects which, as they rarely strike our eyes, permit our minds so much the less to discover their real cause.

Some people, however, may ascribe to the wickedness of mankind what we ascribe to accident. It may be said, that assassins, after putting to death their unfortunate

victims, rubbed over their bodies with combustible substances, by which they were consumed. But even if such an idea should ever be conceived, it would be impossible to carry it into execution. Formerly, when criminals were condemned to the flames, what a quantity of combustible substances were necessary to burn their bodies! A baker's boy, named Renaud, being condemned to be burnt a few years ago at Caen, two large cart-loads of faggots were required to consume the body, and at the end of more than ten hours some remains of the bones were still to be seen. What proves that the combustion in the before-mentioned instances was not artificial is, that people often arrived at the moment when it had taken place, and that the body was found in its natural state. People entered the house of Madame Boiseon at the time when her body was on fire, and all the neighbours saw it. Besides, the people of whom I have spoken were almost all of the lowest class, and not much calculated to give rise to the commission of such a crime. The woman mentioned in the Transactions of Copenhagen was of the poorest condition; Grace Pitt was the wife of a fishmonger; Mary Jauffret that of a shoemaker; and two other women, who resided at Caen, belonged to the lowest order of society. It is incontestible, then, that in the instances I have adduced the combustion was always accidental and never intentional.

It may be seen that a knowledge of the causes of this phenomenon is no less interesting to criminal justice than to natural history, for unjust suspicions may sometimes fall on an innocent man. Who will not shudder on recollecting the case of the unfortunate inhabitant of Rheims, who, after having lost his wife by the effect of combustion, was in danger of perishing himself on the scaffold, condemned unjustly by an ignorant tribunal!

I shall consider myself happy if this picture of the

fatal effects of intoxication makes an impression on those addicted to this vice, and particularly on women, who most frequently become the victims of it. Perhaps the frightful details of so horrid an evil as that of combustion will reclaim drunkards from this horrid practice. Plutarch relates, that at Sparta children were deterred from drunkenness by exhibiting to them the spectacle of intoxicated slaves, who, by their hideous contortions, filled the minds of these young spectators with so much contempt, that they never afterwards got drunk. This state of drunkenness, however, was only transitory. How much more horrid it appears in those unfortunate victims consumed by the flames and reduced to ashes! May men never forget that the vine sometimes produces very bitter fruit—disease, pain, repentance, and death!

*(To be continued.)*

## No. 25.

## *A Treatise on the Cultivation of the Vine, and the Method of Making Wines. By* C. Chaptal.

(Continued from page 138.)

Exposure.—The same climate, the same cultivation, and the same soil, often furnish wines of very different qualities. We may daily see some mountain, the summit of which is entirely covered with vines, present in its different aspects astonishing varieties in the wines they produce. Were we to judge of places by comparing the nature of their productions, we should be often induced to believe that every climate and every kind of soil has concurred to furnish productions which, in fact, are only the natural fruit of the same lands differently exposed.

This difference in the products, arising from exposure alone, may be observed in all the effects that depend on vegetation. Wood cut down in a part of a forest looking towards the north, is far less combustible than that which grows towards the south: odoriferous and savoury plants lose their perfume and savour when reared in fat soil exposed to the north. Pliny had observed that the wood on the south side of the Appenines was of a better quality than that which grew in any other exposure: and every body knows what the effects of exposure are in regard to pulse and fruits.

These phænomena, which are perceptible in regard to all vegetable productions, are particularly so in regard to grapes. A vine turned towards the south produces fruit very different from those which look towards the north. The surface of the soil planted with vines, by being more or less inclined, though with the same exposure, presents also modifications without end. The summit, the middle, and the bottom of a hill give productions very different. The summit, being uncovered, continually receives the impressions of every change and of every movement that takes place in the atmosphere; the winds harass the vine in every direction; a more constant and more direct impression is made on it by fogs; the temperature is more variable and cold. All these circumstances united, cause the grapes there to be less abundant; they come with more difficulty, and in a less complete manner, to maturity; and the wine arising from them is of an inferior quality to that furnished by the sides of the hill, which by their position are sheltered from the greater part of the fatal effects of these causes. The bottom of the hill, on the other hand, presents very great inconveniences: the constant coolness of the soil, no doubt, gives the vines great vigour; but the grapes are never so saccharine, nor

have such an agreeable flavour as those which grow towards the middle region: the air there being constantly charged with moisture, and the soil always impregnated with water, enlarge the grapes, and force the vegetation, to the detriment of the quality.

The most favourable exposuse for the vine is between the east and the south.

Opportunus ager tepidos qui vergit ad æstus.

Small hills rising above a plain intersected by a stream of pure water, give the best wine; but these hills ought not to lie too close to each other:

——————apertos
Bacchus amat colles——————

A northern exposure has at all times been considered as the most fatal: the cold damp winds do not favour the ripening of the grapes; they always remain harsh, sour, and destitute of saccharine principle; and the wine must participate in these bad qualities.

A south exposure is also not very favourable: the earth, dried by the heat in the day-time, presents, towards evening, to the oblique rays of the sun (become almost parallel to the horizon) but an arid soil destitute of all moisture; the sun, which by its position penetrates then under the vine, and darts its rays upon the grapes, which have no longer any shelter, dries and heats them, ripens them prematurely, and checks the vegetation before the period of fulness and maturity has arrived.

Nothing is more proper to enable us to judge of the effects of exposure than to observe what takes place in a vineyard, the ground of which is unequal, and interspersed here and there with a few trees: there all exposures seem to be united in one spot; all the effects thence

depending present themselves to the observer. The stems of vine sheltered by the trees throw out long slender twigs, which bear little fruit, and lead to slow and imperfect maturity. The highest portion of the vine is in general the barest; vegetation there is less vigorous; but the grapes are of a better quality than in low situations. The best grapes are always found in those places most exposed to the south.*

4. *Seasons.*—It is well known that the nature of the vine varies according to the character of the season; and its effects may be naturally deduced from the principles we have established in speaking of the influence of climate, soil, and exposure; since we have shown how to ascertain what effects moisture, cold, and heat, may have on the formation and quality of the grapes. A cold and rainy season, indeed, in a country naturally hot and dry, will produce on the grapes the same effect as a northern climate: this state of the temperature, by bringing together these climates, assimilates and identifies all the productions of them.

The vine is fond of warmth, and the grapes never come to perfection but in dry soil exposed to the rays of an ardent sun. When a rainy year keeps the soil in a state of continual humidity, and maintains a moist, cold temperature in the atmosphere, the grapes will acquire neither flavour nor saccharine principles; and the wine they produce will be necessarily abundant, weak, and insipid.

* The general principles, in regard to the influence of exposure, admit of many exceptions: the famous vineyards of Epernai and Versenai, in the mountain of Rheims, are fully exposed to the north, in a latitude so northern for vines, that it is in those places where the region of the vine suddenly terminates under that meridian.

The vineyards of Nuits and Beaune, as well as the best of Beaugenci and Blois, lie towards the east; those of Loire and Cher lie indiscriminately towards the north and south; the excellent hills of Seaumur face the north; and the best vines of Angers are produced from vines which grow in all exposures,—*Observations de Creuzé-Latouche lues à la Societé d'Agriculture de Paris.*

These kinds of wine can be preserved with difficulty; the small quantity of alcohol which they contain cannot secure them from decomposition, and the large proportion of extractive matter in them determines movements which continually tend to change their nature. These wines turn oily, and sometimes *sour;* but the small quantity of alcohol they contain prevents them from forming good vinegar: they all contain a great deal of malic acid, as we shall prove hereafter, and it is this acid which gives them their peculiar taste; an acidity which is not acetous, and which forms a more prevailing character in wines in proportion as they are less spirituous.

The influence of the seasons on the vine is well known in all countries where vineyards are planted, that, long before the vintage, the nature of the wine may be predicted. In general, when the season is cold, the wine is harsh, and has a bad taste; when rainy, it is abundant, weak, and not at all spirituous: it is therefore destined for distillation, at least in the south of France, because it would be disagreeable to drink, and difficult to be preserved.

The rains which come on when the vintage approaches are always the most dangerous: the grapes then have neither time nor sufficient strength to mature the juice; and they become filled with a very liquid fluid, which holds in solution too small a quantity of sugar for the produce of the decomposition to be either strong or spirituous.

The rains which fall when the grapes are increasing in size, are exceedingly favourable: they assist the organization of the vegetable, furnish it with its principal nutrition, and, if continued heat facilitate the maturation, the quality of the grapes must be perfect.

Winds are always prejudicial to the vine: they dry up the branches, the grapes, and the soil; and they produce, particularly in strong soil, a hard compact crust, which

impedes the free passage of the air and water, and by these means maintains around the roots a putrid moisture which tends to corrupt them. The farmers, therefore, carefully avoid planting vines in situations exposed to wind: they prefer calm situations, well sheltered, where the plants may be exposed only to the benign influence of the luminary towards which they are placed.

Fogs are also exceedingly dangerous to the vine: they are destructive to the blossoms, and do essential hurt to the grapes. Besides the putrid miasmata, which they too often deposit on the productions of the fields, they are always attended with the inconvenience of moistening the surfaces, and of forming on them a stratum of water, more subject to evaporation, as the interior of the plant and the earth are not moistened in the same proportion; so that the rays of the sun, falling upon this light stratum of moisture, cause it to evaporate in an instant; and the sensation of coolness, determined by the act of evaporation, is succeeded by a heat the more prejudicial as the transition is abrupt. It very often happens that the clouds suspended in the atmosphere, by concentrating the rays of the sun, direct them towards parts of the vines, by which means they are burnt. In the scorching climates of the south, it is sometimes observed that the natural heat of the soil, strengthened by the reverberation from certain rocks, or whitish kinds of soil, dries up the grapes exposed to them.

Though heat be necessary for ripening the grapes, giving them a saccharine taste and a good flavour, it would be erroneous to believe that its action alone can produce every effect required. It can be considered only as a mean necessary for maturation, which supposes that the earth is sufficiently furnished with the juices that ought to supply the materials. Heat is necessary; but this heat must not be exercised on dried earth, for in that case it

it burns rather than vivifies. The good state of vines, and the good quality of the grapes, depend then on a just proportion—a perfect equilibrium between the water, which furnishes the aliment to the plant, and the heat, that can alone facilitate its maturation.

5. *Culture.*—The vine grows naturally in Florida, America, and almost every part of Peru. In the south of France, even almost all the hedges abound with wild vines; but the grapes they bear are always smaller, and, though they come to maturity, they never acquire the exquisite taste of the grapes that are cultivated. The vine then is the work of nature, but art changes its products by bringing the culture of it to perfection. The difference which exists at present between the cultivated vine and that which grows wild, is the same as that established by art between the vegetables of our gardens and those of the same kind which grow accidentally in the fields.*

The culture of the vine, however, has its rules as well as its boundaries. The soil where it grows requires great care; it must be often dug up; but it refuses the manure necessary for other plantations. It must here be remarked, that all those causes which powerfully concur to give activity to the vegetation of the vine, alter the quality of the grapes; and here, as in other delicate cases, the culture ought to be directed in such a manner that the plant may receive only poor nourishment if grapes of a good quality are required. The celebrated Olivier de Serres says on this subject, that, "by a public decree, dunging is forbidden at Gaillac for fear of lessening the reputation of the white wines, with which the

* These observations are well worthy of attention; since they will naturally lead to a due investigation of the merits of our native vines; which have one great advantage over those of foreign origin, viz. their being uninjured by our coldest winters. Ed.

people of that district supply their neighbours of Toulouse, Montauban, Castres, and other places, and of thus depriving them of the great profit thence arising, which forms the best part of their revenue."

There are some individuals, however, who, in order to have a more abundant crop, dung their vines; but they thus sacrifice the quality to quantity.

The dung most favourable to the vine is that of pigeons or poultry; dung too fœtid or too putrid is carefully rejected, as it has been proved by observation that the wine often contracts from it a very disagreeable taste.

In the isles of Rhé and Oleron the vines are dunged with sea-weed *(fucus)*; but the wine thence acquires a bad quality, and retains the peculiar odour of that plant. Chasseron has observed, that the same plant decomposed into mould manures the vine with advantage, and increases the quantity of the wine without hurting the quality. Experience has also taught him that the ashes of sea-weed form excellent manure for the vine. This able agriculturist is of opinion that vegetable manure is not attended with the same inconveniences as animal manure; but he thinks, and with justice, that the former cannot be used with advantage except when employed in the state of mould.

The method of cultivating vines on poles or props ought to be commanded by the climate. This method belongs to cold countries, where the vine has need of the whole heat of the sun, naturally weak. By raising them, therefore, on poles placed perpendicular to the ground, the earth, being uncovered, receives all the activity of the rays, and the whole surface of the plant is completely exposed to their action. Another advantage of cultivating on props is, that it allows the vines to be placed nearer to each other, and that the produce is multiplied on equal surfaces. But in warmer climates the

earth requires to be sheltered from the excessive heat of the sun; the grapes themselves have need of being protected from its scorching rays, and to accomplish this view the vines are suffered to creep on the ground; they then every where form a covering sufficiently thick and close to defend the earth, and a great part of the grapes, from the direct action of the sun. But when the increase of the grapes has attained to its maximum, and nothing is necessary but to bring them to maturity, the cultivators collect in bundles the different branches of the vine, uncover the grapes, and by these means facilitate the maturation. In this case they really produce the same effect as is produced by propping; but recourse is had to this method only when the grapes are too abundant, or when the vines grow in soil too fat or humid. In some countries the vines are stripped of their leaves, which produces nearly the same effect; in others, the pedicle of the grapes is twisted to determine the maturity by checking the vegetation. The ancients, according to Pliny, prepared their sweet wines in this manner: *Ut dulcia præterea fierent, asservabant uvas diutiùs in vite, pediculo intorto.*

The method of pruning the vines has also a great influence on the nature of the wine. The greater the number of branches left to one vine, the more abundant the grapes, but the worse is the quality of the wine.

The art of cultivating the vine, and the method of planting it, have a powerful influence on the quality and quantity of the wine. To show the effect which cultivation has on the vine, it will be sufficient to observe what takes place in regard to vines left to themselves; it will be found that the soil, soon covered with foreign plants, acquires firmness, and is afterwards but imperfectly accessible to the air and to water. The vine, being no longer pruned, sends forth weak shoots, and produces grapes

which decrease in size year after year, and which scarcely ever come to maturity. It is no longer that vigorous plant the annual vegetation of which covered the soil to a great distance. The grapes are no more that well-nourished fruit which afforded sound and saccharine aliment; the vine becomes stunted, and its fruit, of a bad and weak quality, attests the languid and ruinous state of the soil. By what are these changes produced? By the want of cultivation.

We may therefore consider the good state of the soil as the work of nature: all the art consists in stirring it, turning it up several times, and at favourable periods. By these means it is freed from all noxious plants, and it is better prepared for receiving water, and for transmitting it with more ease to the plant; the air also can penetrate to it with more ease, and thus all those conditions necessary for proper vegetation are united. But when, on account of some particular speculations, it is necessary to obtain wine in greater abundance, and when the quality may be sacrificed to this consideration, the vines in that case may be dunged, more shoots may be allowed to the stems, and all the causes which can multiply the grapes may be united.

## II. *Of the Time most favourable for the Vintage, and the Processes employed during that Period.*

Olivier de Serres observes, with great justice, that if the management of the vine requires great skill and intelligence, it is at the period of the vintage that these things are necessary, to obtain in perfection and abundance the fruits which Providence thence distributes to us. Every body allows that the moment most favourable for the vintage is that when the grapes come to maturity; but this maturity can be known only by the union of the following signs:

1st, The green stalk of the grapes turns brown.

2d, The grapes become pendulous.

3d, The stones of the grapes lose their hardness; the pellicle becomes thin and transparent, as is observed by Olivier de Serres.

4th, The clusters and grapes can be easily detached from the twigs.

5th, The juice of the grapes is savoury, sweet, thick, and viscid.

6th, The stones of the grapes are free from any glutinous substance, according to the observation of Olivier de Serres.

The fall of the leaves announces rather the return of winter than the maturity of the grapes; this sign, therefore, is considered as very uncertain, as well as putridity, which a thousand causes may occasion, none of them sufficient to enable us to deduce from them a proof of maturity. When the frost, however, makes the leaves to fall, the vintage ought not to be longer deferred, because the grapes are then susceptible of no further maturity. Their remaining on the vine could tend only to promote putrefaction.

"In 1769, the grapes, still green," says Rozier, "were surprised by the frost on the 7th, 8th, and 9th of October. They gained nothing more by remaining on the vines till the end of the month; and the wine was acid and of a bad colour.

There are some qualities in wine which cannot be obtained but by suffering the grapes to dry on the twigs. Thus, at Rivesaltes, and in the islands of Candia and Cyprus, the grapes are suffered to remain exposed to the winds before they are cut. The grapes which furnish tokay are dried; and the same process is employed for some of the sweet wines of Italy. The wines of Arbois, and of Chateau-Chalons, in Franche-Comté, are

produced from grapes which are not cut till towards the end of December; at Condrieu, where the white wine is celebrated, the grapes are not cut till near the middle of November. In Tourraine, and other places, a kind of wine called *vin de paille* is made, by collecting the grapes during dry weather, and when the sun is in full force; they are spread out, so as not to touch each other, on hurdles, which are exposed to the sun, and then shut up when he is set; the grapes which rot are carefully removed, and when the whole are well dried, the juice is expressed and made to ferment.

Olivier de Serres says, it has been proved by experience, that the best period of the moon for collecting grapes in order that they may keep, is her decrease rather than her increase. He, however, allows, that when the grapes are ripe it is better to consult the weather than the moon; and in this we perfectly agree with him.

But there are some climates where the grapes never come to maturity: such are almost all the northern parts of France; and in that case the grapes must be collected green, that they may not be exposed to rot on the twigs. A moist and rainy autumn must increase the bad quality of the juice. All the vineyards in the neighbourhood of Paris are in this situation; the vintage there is, of course, earlier than in the south, where the grapes never cease to ripen, though the heat of the sun continually decreases.

When the necessity of commencing the vintage has been ascertained, a great many precautions must be taken before it is begun. In general, the vintagers ought not to venture to labour but when the soil and the grapes are dry, and until the weather appears so settled as to give reason to believe that their occupations will not be interrupted. Olivier de Serres recommends, not to collect the grapes till the sun has dispersed the dew deposited

on them by the coolness of the nights: this precept, though generally true, cannot be universally applied; for in Champagne the vintagers collect the grapes before sunrise, and suspend their labours towards nine in the morning, unless the fogs occasion humidity throughout the whole day: it is only by this care that they obtain white and brisk wines. It is well known in Champagne, that twenty-five casks of wine are obtained instead of twenty-four, when the vintagers labour during the continuance of the dew; and twenty-six during the fog. This process is every where useful when wines exceedingly white and brisk are required. Except in the above cases the grapes ought not to be cut until the sun has dispersed all the moisture from their surface.

But some precautions are necessary to ascertain the period most proper for the vintage, and some must be observed in regard to the mode of operation. An intelligent agriculturist will not commit the care of cutting the grapes to inexpert mercenaries: as this part of the labour is not the least important, we shall here give a few observations on it.

1st, A sufficient number of vintagers ought to be engaged that the vat may be filled in one day: this is the only method of obtaining an equal fermentation.

2d, Women on the spot should be preferred; and none ought to be employed but those who have become expert in this kind of labour.

3d, The labourers ought to be under the superintendance of a strict and intelligent overseer.

4th, They ought to be prohibited from eating the grapes, both to prevent crusts of bread and other food from being mixed with the juice, and to preserve for the press the ripest and most saccharine grapes.

5th, The tails of the grapes ought to be cut very short, and the operation ought to be performed with a pair of

good scissars. In the *Pays de Vaud* the grapes are detached by means of the nail, in Champagne a pruning-knife is employed: but the two last methods are attended with the inconveniency of shaking the stem.

6th, No grapes ought to be cut but those sound and ripe: those which are putrid ought to be rejected, and those still green must be left on the twigs.

In all places where the cultivators are desirous to obtain wines of a good quality, the grapes are collected at two or three different times. In general, the first vat-full of juice is always the best. There are some countries, however, where the grapes are almost collected without distinction, and at one time; the juice is expressed without picking, but the wines are very inferior to what they might be, if more care were employed in the operations of the vintage.

When the grapes are to be picked, the following rules may be observed: To cut only those clusters which are best exposed, those the grapes of which are equally large and coloured; to reject all those which have been sheltered, and near the ground; and to prefer those which have ripened at the bottom of the vines.

In the vineyards which furnish the different kinds of Bourdeaux wine, the grapes are carefully picked; but the method of picking the red grapes differs from that employed for picking the white: in picking the red, neither the putrid nor the green grapes are collected; in regard to the white, the putrid and the ripest are preferred, and the picking is not begun till a great many of the grapes have become putrid. This operation is so minute in certain districts, such as Sainte-Croix, Loussiac, &c. that the vintage there continues two months. In Medoc the operation of picking is performed twice for the red wines; at Lagnon it is performed three or four times;

for the white grapes at Sainte-Croix, five or six; at Langoiran from two to three; and two in all the Graves.

In some countries a vintage composed of grapes perfectly ripe is dreaded. The cultivators apprehend that the wine will be too sweet, and they remedy this inconvenience by a mixture of large grapes less ripe. In general, the wine is not brisk and pungent, but when grapes are employed which have not acquired perfect maturity. This is what is practised in Champagne and other places.

In some countries where the grapes never come to absolute maturity, and consequently cannot develope that portion of saccharine principle necessary for the formation of alcohol, the cultivators proceed to the vintage before the appearance of the hoar-frosts; because the grapes still possess a sharp principle, which gives a peculiar quality to the wine. It is observed in all those places, that a degree more towards maturity produces wines of very inferior quality.

7. When the grapes are cut they ought to be put into baskets; taking care not to employ any of too large a size, lest the juice should be lost by the superincumbent weight. As it is very difficult, however, to transport the grapes from the vineyard to the vat without altering them by pressure, and consequently without expressing more or less of the juice, baskets ought not to be employed but to receive the grapes as they are cut; and when full they ought to be emptied into boxes or scuttles, that they may be more conveniently conveyed to the vat. They ought to be carried in carts, or on the backs of men, or of mules: which of these three means are to be employed must be determined by local circumstances. Carts are, no doubt, less expensive, though attended with this inconvenience, that the grapes may be injured by the re-

peated shocks they experience: the motion of a horse is gentler, as well as more regular. Scuttles are employed in all countries where the grapes are not very ripe, and where there is little danger of their being injured by the carriage.

*(To be continued.)*

## No. 26.

*Agenda; or a Collection of Observations and Researches the Results of which may serve as the Foundation for a Theory of the Earth. By* M. de Saussure.

(Continued from page 130.)

### CHAP. VI.

*Observations to be made on Rivers and other Currents of Water.*

1. Extent of their course, and their inclination from their sources to their mouth.

2. Their dimensions, breadth, depth, and velocity in the different parts of their course.

3. Quantity of their periodical increase and decrease at different seasons; their temperature during these seasons; and the causes of these variations.

4. Limits and causes of their extraordinary inundations.

5. Whether they are navigable, and to what distance from their mouth?

6. The nature, purity, and salubrity of their waters.

7. The nature of the sand or mud which they carry along with them; and to what distance they may be traced on the banks or at the bottom of the sea where

their mouths are situated. M. Besson even wishes that the traveller should be furnished with a wooden vessel (*sebille*) to wash the sand and separate the more ponderous particles, which may consist of metal or precious stones. The motion of the waves is also often sufficient to separate, in distinct bands or zones, particles of different gravity.*

8. Nature of the rolled pebbles found on their borders.

9. The quantity and kinds of fish by which they are characterised.

10. To inquire, as in regard to the sea, whether it appears that they contain more or less water than formerly, and whether they have changed their courses.

11. As the greater part of these qnestions may be applied to lakes, it is not necessary to make them the subject of a separate chapter. I shall insist only on their nature and the measure of their depth; on the temperature of their bottom compared with that at their surface in different seasons; and also on the vestiges of their extent and height in the remotest ages, compared with their present state.

## CHAP. VII.

### *Observations to be made on the Plains.*

1. The extent, limits, and inclination of a plain; its height above the level of the sea; its relaton with the hills or mountains by which it is bordered. To form a proper idea of it as a whole, it would be necessary to ascend some eminence commanding a view over it.

2. The vegetable earth; its nature and thickness in different parts, compared with the time since it has been

* Moyens de rendre utiles les voyages des naturalistes. Esprit des Journaux, Avril, 1794.

cultivated, with its productions, and the kind of culture. The nature of the basis on which that earth rests.

3. Rolled pebbles. (*See Chap.* VIII.)

4. Sand, argil; their nature; thickness of their beds.

5. Nature and thickness of the strata of the earth at the greatest depth possible to be reached, by taking advantage of the time when wells, mines, and other excavations are dug. This research is particularly interesting when these excavations are extended below the level of the sea.

6. Marle-pits; their external appearances; whether they contain shells, and of what kinds; extent of their beds, and their thickness; analysis of them, at least with acetous acid; the uses for which the marle is employed.

7. Clay-pits; quarries of lime-stoue, gypsum; mines of coal, &c.

8. Whether the plains exhibit at their surface, or contain in the interior parts of the earth, vestiges of marine bodies, petrified wood, bones, or other substances foreign to the soil and to the country.

9. Internal temperature of the earth, ascertained either by direct experiments, or by observing that of the deepest wells or cellars; or by that of springs, which do not freeze in winter, and which remaining cool in summer, seem to come from the greatest depths.

10. Whether any fact can be observed which might oblige us to have recourse to the hypothesis of a central fire.

11. Basons surrounded by hills or mountains; whether they seem to have been formerly filled with water; whether the water appears to have been fresh or salt; whether any thing indicates the period of its retreat, and if there are any traces of the apertures through which it escaped.

## CHAP. VIII.

### *Observations to be made on Rolled Pebbles.*

1. The nature and size of those found in any particular district.

2. To examine, above all, whether there is any kind which may be considered as peculiar to that district, or which may be proper to characterise it; or even, whether the absence of any kind or class might not be sufficient to form that character.

3. Whether those found on the borders of any river might be considered as having been thrown up by that river, or whether it only exposed them to view by washing away the soil which it watered.

4. After establishing the character of the pebbles of a certain district, one might follow, as it were, their traces, and form conjectures both respecting their origin and the route they have pursued.

5. The increase of their size will show that they approach their origin, or *vice versa;* but care must be taken that other veins of pebbles crossing the former may not conceal the course of those which you are tracing out.

6. A consideration of the pebbles, and still more that of rolled blocks, or, at least, such as are foreign to the soil which bears them; of the height at which they are found, and of the large valleys opposite to their present situation, may afford some indications of the direction, size, and force of the currents produced by the grand revolutions of the earth.

7. A consideration of those blocks which rest on solid rock, and which seem still to occupy the place where they were deposited, may, by the state of these rocks, give an idea of the time elapsed since their arrival.

8. How far can the transportation of these great blocks

to considerable distances be considered as a general phenomenon? or, is it only a particular phenomenon, arising from some local cause?

9. Can it be believed that such of those blocks as at present occupy elevated sites on mountains, have been transported by billows or waves, which raised them gradually from the bottom of the valleys, and that they must at first have descended to these elevated situations.*

10. Or was it by enormous tides, of eight hundred toises, for example, that these blocks were transported to the tops of the mountains?

## CHAP. IX.

### *On Mountains in general.*

1. To consider whether a mountain be insulated, or whether it forms part of an assemblage of mountains connected with each other in the form of groups or chains.

2. If it be a group, to determine its form and dimensions, and the manner in which its parts are connected.

3. If it be a chain, to determine its direction, its breadth, and its extent; whether it be single or compound; and, in the latter case, the nature and disposition of the partial chains which enter into its composition.

4. If a mountain be insulated or considered separately from its chain, or the group of which it forms a part, to determine its form, its height, and other dimensions.

5. To determine the form and situation of its summit or most elevated part; those of its declivities and bottom.

* May not the transportation of these blocks, at least in cold countries, be ascribed sometimes to floating ice? TIL.

6. The situation of its precipices in regard to the sea and the nearest plains, valleys, and mountains.*

7. Its nature, and the kind of stone of which it is composed. Whether it be homogeneous; that is to say, of the same nature throughout all its parts; if it be not, to determine the dimensions of its different parts.

8. Whether it consists of indivisible masses, or masses divided by strata.

9. Whether it contains mines either in veins or strata: the nature of these mines.

10. To observe the height at which the snow is perpetual, or what Bouguer calls *the lower limits of the snow*, and the height at which trees, shrubs, and plants, with distinct flowers, cease to grow. These observations have been neglected in the northern countries.

11. To observe carefully the increase or decrease of the glaciers: to determine them, in particular, by what are called *moraines*, that is to say, those heaps of stones now or formerly deposited by the glaciers on their edges and at their extremities.

11. A. To ascertain whether there are found in the mountains sunk or petrified trees, at heights at which they would not grow at present; and to examine if it thence follows that there may have been a time when the upper strata of the atmosphere were warmer than they are at present.

12. Caverns: if there are any, their form and dimensions; the nature of their sides; the nature and inclination of their bottom; vestiges of the effects of the water by which they may have been formed; stalactites and incrustations, foreign bodies and bones which they may contain.

13. Whether there are found vestiges of large basons

* And in regard to the four cardinal points; whether any side is more steep than another, and which side? TIL.

disposed in stories above each other, and which might have served as reservoirs to different seas that afterwards might have run off and united themselves in the basons of the present seas.

## CHAP. X.

### *Observations to be made on the Strata of the Earth and Mountains.*

1. The first question is to determine whether a mountain or any mass of earth and stone is or is not divided by strata.*

2. What, in regard to the theory of the earth gives importance to the question, whether a mountain is or is not stratified, or composed of strata, is the supposition that stratified mountains have been formed by the successive deposition of substances before suspended in a fluid, while those which exhibit no signs of strata may be supposed to owe their origin to a simultaneous creation, or an accumulation not formed in a fluid, or which, at least, had nothing successive or regular, or in which there remain no traces of regularity.

3. If the mountain or mass exhibits no marks of division, the question of its being stratified or not is superfluous. We shall suppose then that it presents divisions, and require to know whether these divisions may be called *strata*. The solution of this question depends upon three considerations: viz. The regularity of these divisions, or their parallelism. Their number: the greater the number, the more it excludes the idea of fortuitous

* The word *stratum*, originally synonimous with that of *bed*, expressed the situation of a substance extended horizontally, and with an uniform thickness, on a plain and horizontal base. But the signification of this word has been enlarged, and it is now employed to express the situation of substances extended with an equal or almost equal thickness on bases which are neither plain nor horizontal. *Note of the Author.*

Might not the term *stratum* be reserved for those that are horizontal, and the name of *banks* be given to others? Tr.

parallelism. The parallelism of these divisions with the laminæ or parts discernible in the inside of the mass.

4. Though the strata, in general, have the form of a parallelopipedon, some are seen cuneiform; in others are observed alternate swellings and constrictions; and others are seen ramified, dividing themselves sometimes into two or three, or two and three uniting and forming themselves into one.

5. Besides the form of the strata, to observe their extent, either in the same mountain, or in several mountains near each other, or even at a distance.

6. To observe also their inclination, or the angle which they form with a horizontal line, and the point of the horizon to which their declivity is directed.

This last observation determines the direction of their planes, or the two opposite points of the horizon through which their planes would pass, were they prolonged, after being made entirely straight. This direction of the planes is of importance to be considered, especially in vertical strata.

7. To examine whether this direction is parallel, oblique, or transverse to the direction of the body itself of the mountain, the chain of which it makes a part, and the adjacent valleys.

8. To examine also whether the declivity of the strata is conformable to that of the external surface of the mountain; that is to say, whether they descend towards the outside of the mountain, or towards the interior part.

9. To examine next whether the inclination is the same from the bottom of the mountain to the summit, or whether it varies at different heights; whether it be the same or different at the opposite sides of the same mountain. Strata in the form of a fan.*

* Voyages dans les Alpes. § 656 and 677.

10. It is of importance to observe, in inclined or vertical strata, whether their thickness is not greater at their basis than at their summit.

11. To observe the joinings of the strata, and whether any substance different from that of the strata is placed between them, and what is the nature and thickness of this substance.

12. To observe whether the contiguous or corresponding joinings of these strata are smooth or unequal; whether there are observed in them any knots that exhibit traces of crystallization or undulations proceeding in a certain direction.

13. In mountains consisting of strata different in their nature, or of different thickness, to observe whether their return is periodical, so that the same order recommences after a certain number or determined interval.

14. Whether, at the bottom of a mountain consisting of horizontal strata, there are not found mountains composed of vertical strata resting against the basis of that mountain.

15. In bent or circular strata, to observe in the elbows or points where the flexion is greatest, whether the strata are or are not broken.

16. When the strata have the form of a C, to observe whether at the back of the C there is not a vacuity, which proves that the upper part has been thrown above the under part.

17. To examine, in general, whether the strata exhibit traces of violent convulsions, which may have changed their primitive situation; or, on the contrary, whether the whole, as well as the straightening of the strata, may be explained by simple sinking down.*

* 18. To observe, whether, on approaching the high primitive mountains, the calcareous strata do not seem to have been reversed in a more violent manner. B.

## CHAP. XI.

### *Observations to be made on Fissures.*

1. Their form, dimensions, breadth, extent, and direction.

2. Their situation; measure of their inclination; direction of that inclination in regard to the cardinal points, and in regard to the adjacent mountain and valleys.

4. To observe, above all, the direction of fissures in regard to that of the planes of the strata; because fissures, as is presumed, being produced, in general, by the earth sinking down, and this sinking down being the effect of pressure, fissures have been originally vertical or nearly so; and, on the other hand, because the strata having originally been horizontal or nearly so, the situation of fissures, in regard to the strata, and the direction of both in regard to the horizon, may give some idea of the situation which the strata had when the fissures were formed, and even of the changes of situation which the mountain afterwards experienced.

Thus, fissures perpendicular to the planes of the strata, indicate that these fissures were formed when the mountain was still in its primitive situation; and if they are also perpendicular to the horizon, it proves that the mountain is still in the same situation: but if fissures perpendicular to the strata are inclined to the horizon, we may conclnde that the mountain has changed its situation since these fissures were formed.*

5. When the fissures are filled with matter different from the body of the mountain, that matter is called a vein.

6. Lastly, one must examine, in both sides of the same

* An explanation and application of these principles may be seen in my Travels, § 1048, 49, 50, and 1218.

fissure, whether the strata correspond at the same height, or whether the corresponding strata are lower on one side than on the other. The first case indicates that the fissure has been produced by mere bursting asunder; and the second proves, besides, a sinking down of the earth.*

## CHAP. XII.

### *Observations to be made on the Valleys.*

1. To observe the direction of valleys. Those parallel to the chain of the mountains where they are situated are called longitudinal; those which intersect it at right angles, transversal; and those which follow an indeterminate direction, oblique.

2. To observe this direction, especially in regard to that of the planes of the strata of the mountains.

3. Dimensions of the valleys; their length, breadth, depth, and the form of their transversal section.

4. The re-entering and salient angles: whether opposite to each salient angle, which forms a side of the valley, the side or opposite mountain forms a re-entering angle; or, on the other hand, whether the valley does not present alternate constrictions and swellings?

5. Whether the opposite mountains correspond by their height, their form, the inclination of their corresponding faces; the situation of their strata, or their nature?

6. Answers to these questions will serve to determine whether the valley may or may not be considered as a large fissure produced by the bursting asunder of the mountains which it traverses.

7. If the lateral valleys which terminate at a principal valley, as the branches of a tree at its trunk, correspond

* To observe whether this sinking down has not always taken place on that side which looks towards the flat country. Til.

or not; or, in other words, whether the branches of that trunk are opposite or alternate?

The answers to these two questions are very important for the solution of this question: Whether the valleys have been excavated by currents of the sea?

9. Whether there are seen a great number of narrow valleys, of no great depth at their most elevated part, but becoming wider and deeper in proportion as they descend lower, which would seem to indicate that their excavation has been the effect of the fall and descent of water; especially if the strata have the same inclination on each side of the valley, and if its formation cannot be explained by a sinking down or heaving up of the earth.

10. To observe in a valley, the corresponding mountains of which are of the same nature, whether the strata of these mountains do not descend on each side towards the bottom of the valley, which would indicate that the valley has been produced by a sinking down of the earth, or perhaps by the opposite faces being thrown up.

11. There are two other cases possible when the strata have not the same situation on both sides of the valley. 1. When the strata rise up on each side against the valley. 2. When on one side they descend into the valley, and on the other rise against it. These two cases afford room for suppositions too various to be here detailed.

12. To search on the vertical sides of the valleys for vestiges of the erosion of the water.

13. To observe the bottom of the valley, its breadth, inclination, and nature. The vegetable earth, its quantity and quality; fragments, either from neighbouring mountains, or brought from a distance, either angular or rounded; to examine whether they are more voluminous towards the top of the valley. Nature and depth of the

strata which are below the vegetable earth; whether the pebbles are larger in the deepest strata: nature of the rock which forms the solid basis of the valley.

14. Whether a valley contains foreign pebbles, that is to say, which come from the neighbouring mountains: to examine to what height they are found on the sides of the mountains; what may be their origin, and what way they may have been conveyed.

15. In the valleys which contain no foreign pebbles, one may follow the traces of those which are there discovered, and thus ascend to the rock from which they were detached: this has often led to curious and useful discoveries.

## CHAP. XIII.

### *Observations to be made on Tertiary Mountains, or those composed of the Wreck of other Mountains.*

1. Whether they do not form the external border of other chains of mountains.

2. Whether, at the extremity of great valleys which issue from grand chains of mountains, there are not found small hills and even tertiary mountains, which seem to have been formed by the accumulation of matters deposited by enomous currents that issued formerly from these valleys.

3. Whether their strata do not descend on the side, whence the matter of which they are formed has proceeded?

4. Size and nature of the fragments, sand and earth, of which they are composed.

5. To observe the order which has been followed in the successive deposits of the matters of which they are formed.

6. To compare them with the substances produced by

the mountains, whether primitive or secondary, from which they are supposed to have issued.

7. To examine whether there are found there any vestiges of organized bodies.

8. To examine whether there are not found, in their exterior part or surface, strata that seem to have been deposited by stagnant water, or at least water not much agitated; or, on the contrary, whether every thing in them seems to have been transported by some violent movement?

## CHAP. XIV.

### *Observations to be made on Secondary Mountains.*

1. To determine with precision the distinguishing characters between primitive and secondary mountains. This is difficult, especially in the genera found equally in primitive mountains, such as slate, serpentines, and some kinds of *trapps* and porphyry. With regard to the calcareous, a granulated fracture seems to characterize the primitive. M. Fichtel, however, doubts this principle, and believes that there are secondary granulated, calcareous, and compact primitives.

2. Is it certain, as Dolomieu asserts, that in secondary mountains there are no strata composed entirely of granulated and crystallized stones?

3. To determine the respective antiquity of the genera and species of the earths and stones which enter into the composition of secondary mountains. Might we not assign characters by which, in the same genus, we might distinguish the most modern species and varieties?

4. Whether the secondary mountains are always inclined in such a manner as to lean towards the nearest primitives?

5. Whether their superior stratum, especially in the

compact calcareous, is not often a *breche,** the angular fragments of which are for the most part of the same nature as the stratum that serves them as a basis, and united by a cement of the same nature ?†

5. (A). To observe in the chalk mountains the flints contained there; their bulk, their form, &c.; whether they are disposed in beds; to reflect on their origin: even researches on the petro-silex contained in the compact calcareous stones; and, lastly, the same on the hard *rognons,* or touch-stones contained in the slate mountains: to ascertain whether these petro-silex and rognons are not found in the primitive mountains.

6. Whether there are found in secondary mountains vestiges of organized bodies, and at what elevation. This observation is important above all in the Austral hemisphere.‡

7. Whether there are found, either at their surface, or in their interior parts, rolled pebbles or blocks of a nature different from that of the same mountain, and to what height? ||

8. Whether these mountains seem to have been formed by the alluvion of violent tides, or by the accumulated deposits of stagnant water?

9. Whether the secondary mountains do not present themselves sometimes in vertical strata, or at least strata very much inclined, and with sharp naked peaks like those of some primitive mountains?

10. Whether, in the same secondary mountain, there are found strata of different kinds of stones oftener than in the primitive?

* Breche is a kind of hard marble found in the Pyrenees.

† Voyage dans les Alpes, vol. i. § 242. A. and 243.

‡ 6. A. Do not organized bodies contribute sometimes to the hardness of stones, especially those that contain iron, by bringing that iron near to the metallic state? *Hypothesis of Gad in Mem. of the Acad. of Sweden,* 1787. Tr.

|| See Dolomieu's Memoir, Journal de Physique, 1791, vol. ii.

11. Whether, in secondary mountains, on the other hand, each stone is not generally simple, and not compound as in the primitive?

12. To make researches respecting the origin and antiquity of mountains of gypsum, and their relation with mountains of salt and salt springs.

*(To be continued.)*

### *Observations on Maddering; together with a simple and certain Process for obtaining, with great Beauty and Fixity, that Colour known under the Name of the Turkey or Adrianople Red. By* J. M. Haussmann.

(Concluded from page 146.)

#### *The Process.*

After making a caustic ley of one part of good common potash dissolved in four parts of boiling water, and half a part of quicklime, which I afterwards slaked in it, I dissolved one part of powdered alum in two parts of boiling water; and while this solution of sulphate of alumine was still warm, to avoid re-crystallization, I speedily poured into it successively, always stirring it without interruption, the above-mentioned caustic ley, till the alumine it had at first precipitated after saturation to excess with sulphuric acid had been redissolved. I left at rest this solution of alumine, which exhaled ammonia, and which, on cooling, formed a precipitate of sulphate of potash in very small crystals. I then mixed a thirty-third part of linseed-oil, with which the alkaline solution of alumine formed a kind of milky liquid.* As the oil gradually separates itself from this mixture under the ap-

* In fact, a saponaceous liquor is formed containing alumine. Tr.

pearance of cream, it must not be employed till it is again shaken. The skains of cotton or linen ought to be successively immersed in it, and equally pressed, that they may be then exposed to dry on a pole in the order in which they have been taken from the mixture. They must be dried under shelter from rain in summer, and in a warm place in winter, and be left in that state for twenty-four hours: they must then be washed in very pure running water, and be again dried; after which they are to be immersed in an alkaline ley, pressed and dried a second time in the same manner as the first, taking care, however, to recommence the immersion in the ley with those skains which have been last in the oily mixture, because the first never fail to carry away a larger portion than the last: it will be proper also to consume the mixture each time, that it may not have leisure to attract the carbonic acid with which the lower region of the atmosphere is always charged, especially in manufactories; for the alkali, by passing to the state of carbonate, suffers the alumine to be precipitated, and loses the property of mixing with the oil.

Two immersions in the alkaline solution of alumine mixed with linseed-oil will be sufficient to obtain a beautiful red; but, by continuing to impregnate the skains a third and even a fourth time with the same circumstances as the first, colours exceedingly brilliant will be produced.

The intensity of the red proposed to be obtained will be in proportion to the quantity of the madder employed. By taking a quantity of madder equal in weight to that of the skains, the result will be a red, which, by clearing, will be changed to a rosy shade: on the other hand, shades of crimson, more or less bright, will be obtained by employing two, three, and even four times the weight madder, without ever forgetting the addition of chalk, if

the water employed does not contain some of it. Four parts of this colouring substance will produce a red too intense and beautiful to be employed in commerce, as it would be too dear to find purchasers.

By making an oily alkaline solution of alumine with two or three parts of water, and impregnating the skains twice, and even four times, in the manner above mentioned, bright shades will be produced without the use of much madder; but they will not have the same intensity as those procured with even as little madder by means of the same solution concentrated.

The best method of obtaining shades lively as well as bright, is to expose the dark reds for a considerable time, when they have been cleared, to the action of a ley of oxygenated muriate of potash, or of soda with excess of alkaline carbonate, in order to have such a degree of shade as may be required: but it may readily be conceived that this method would be expensive.

To have the oily alkaline solution of alum nearly in the same state of concentration, it will be necessary to employ an areometer to determine the degree of strength of the caustic ley before it is employed for the solution of the alumine. This caustic ley must be made with the best common potash that can be procured, and the degree it gives by the areometer must be noted, in order that, if potash of an inferior quality be afterwards employed, the ley obtained may be carried to the fixed degree by evaporation.

Caustic ley made with four parts of good common potash* cannot contain a large quantity of foreign salts. By making it on a large scale, when the limpid part has been decanted, it will be necessary to shake the deposit, for some time, twice every day, that the rest of the alka-

* I have no doubt that, where potash cannot be procured, soda might be employed. THE AUTHOR.

line liquor may be decanted; and that none of what still remains in the deposit may be lost, it ought to be diluted with more water, which may be afterwards employed to lixiviate the cotton, which must be well purified and cleaned before it is dyed; which may be done by lixiviating and soaping, or merely boiling it in water, and then rinsing and drying it. As wringing with the hands may derange the filaments of the skains of cotton and linen, and consequently weaken the thread, it will be proper, in operating on a large scale, to squeeze them by means of a press.

In regard to thread or linen to be dyed of a beautiful dark and fixed red, it must be well bleached, and impregnated at least four times successively with the oily alkaline solution; because, not only alumine and metallic oxides adhere with more difficulty to linen than to cotton, but because these mineral substances, when coloured, abandon linen much easier than cotton when clearing. It still remains to examine whether, between each impregnation with the oily alkaline solution of alumine, cotton or linen thread requires to be left at rest for a greater or shorter time before it is rinsed and dried.

All fat oils may be employed in the mixture with proper precautions; but linseed-oil mixes better, and remains longer suspended in the alkaline solution of alumine: I never tried fish-oil, which, perhaps, would be preferable. It is probable also, that in operating on a large scale, it would be best to diminish the quantity of linseed-oil in the mixtures with the alkaline solution of alumine; for I have had reason often to observe that too much oil hurts the attraction of the colouring parts of the madder: a thirty-third part of linseed-oil always produced the best effect in my trials on a small scale.

In regard to the process of dyeing cotton and linen thread, sufficiently charged with alumine, by the oily al-

kaline solution of that earth, the skains must first be disengaged from every saline substance, as well as from the superfluous oil, by rinsing them a long time in very pure running water; after which they must be arranged, without drying them, on an apparatus, which the operator may construct according to the form of the boiler,—in which it is to be placed in such a manner, that during the process of dyeing, the skains may be continually shaken and turned, in order to catch every where, and in an uniform manner, the colouring particles. The bath must be composed of madder, mixed with a sixth of pounded chalk, and diluted with about 30 or 40 parts of water. The heat must be carried only to such a degree that the hand can be held in the bath for an hour without being scalded; and it is to be maintained at this degree for two hours, either by diminishing or increasing the fuel. Three hours dyeing will be sufficient to exhaust the madder: the skains when taken from the bath must be washed in a large quantity of water to cleanse them; they are then to be cleared by boiling them a pretty long time in water containing bran inclosed in a bag, adding soap and alkaline carbonate to give the red a rosy or carmine shade.

As I never had occasion to dye cotton or linen thread on a large scale, I employed a small boiler, which served me at the same time for the process of clearing: in the latter operation I confined myself to boiling the skains, properly arranged, in water containing a bag filled with bran, for eight hours successively; and, that I might not interrupt the ebullition, I replaced the evaporated part by the addition of more boiling water. In this clearing I employed neither soap nor alkali; yet I obtained a red superior in beauty and fixity to that of the Levant, and which, in every respect, will bear a comparison with the best colours dyed in France.

For dyeing my red, I employed three parts of the best madder for one part in weight of dry cotton thread.

With the precaution I took to obtain an uniform shade I could have dyed at one time, but I should always recommend performing this operation at two different times, taking each time half a portion of madder and of chalk, if the skains cannot be continually turned in the boiler: it may serve also for clearing, by adapting to it a cover so as to suffer very little of the vapours to escape, because it would be too expensive to replace the part evaporated by more boiling water. By operating on a large scale, and concentrating the heat in the boilers, keeping them almost close, there, perhaps, would be no need of employing eight hours ebullition to clear and fix the colours. I have every reason to believe that this clearing of the Turkey red gave rise to the idea of bleaching with steam: it must have been seen that colours by being cleared lose considerably in regard to their intensity; and perhaps it has been observed at the same time that the packthreads employed for arranging the skains were bleached during the clearing, especially when alkalies were added.

A great variety of colours and of different shades may be obtained by following the process here described for obtaining beautiful and durable reds. In this case, the oily alkaline solution of alumine must not be employed till the required shade of oxide of iron or indigo blue has been given; but whatever may be the colour or shade which you wish to give, before you fix the alumine on the skains of cotton or linen, these skains must always be first well boiled, by which means the adhesion of the indigo fecula as well as that of the oxide of iron will be increased, in the same manner as that of alumine coloured by the colouring parts of madder when subjected to the action of the heat of boiling water before they are

impregnated with the oily alkaline solution of alumine. As the method of dyeing indigo blue in all its shades is well known, it is needless to detail it; and as to giving a rusty yellow colour, which may be done at little expense, nothing is necessary but to moisten the skains well with a solution of the sulphate of iron, to press them equally, and then to immerse them in a caustic ley of potash, which will precipitate and fix the oxide of iron of a disagreeable colour, but which will not fail to assume a rusty yellow shade by attracting and becoming saturated with the oxygen of the atmosphere: thus yellow will be more or less dark according to the quantity of the sulphate of iron in solution. More intensity and even more equality may be given to the rusty yellow by moistening the skains a second time in the ferruginous solution, and immersing them in the caustic ley. Care, however, must be taken not to use soda for this operation, because it generally contains sulphur, which blackens oxide of iron by mineralizing it.

The skains coloured blue and rusty yellow, treated with oily alkaline solution of alumine, will produce, by maddering, dark purple and chamois colours, violet, lilac, puce, mordoré, &c. It may be easily conceived, that if, instead of maddering, the same skains prepared for maddering be dyed with kermes, cochineal, and Brazil wood, logwood, wood of St. Martha, woad, yellow wood, quercitron, yellow berries, &c. a great variety of colours will be obtained: the shades may even be varied *ad infinitum* by mixing the colouring ingredients with each other in different proportions. The affinity of adhesion of the colouring parts of all these ingredients varies also to such a degree, that the shades arising from a yellow or olive-green will be changed or totally metamorphosed by a second dyeing with madder, kermes, cochineal, or Brazil wood; and will furnish orange shades, capucine,

carmelite, burnt bread, bronze, &c. As the preliminary preparation of the skains by the oily alkaline solution of alumine might be too expensive for some of these colours, the process I described in the *Annales de Chimie* for the year 1792, p. 250, may be substituted in its stead. This process consists in treating the skains alternately with soap and sulphate of alumine, the excess of the acid of which has been saturated with one of the alkaline carbonates or with lime : this method is very expeditious. In the course of a day, especially in summer, the skains may be prepared and dyed red as well as other colours; which, for the most part, may be subjected to ebullition, and will bear clearing with bran for a quarter or half hour, and even some of them for a whole hour. It is also to be observed that there are none but madder colours, the alumine and oxide of iron bases of which have been fixed on the stuffs by means of the oily alkaline solution, that can acquire perfect fixity by the action of heat of boiling water ; and that the fixity is very inferior in all madder colours the earthy and ferruginous bases of which have been applied to stuffs by means of acid solvents.

Alumine, fixed in abundance on cotton or linen stuff by means of a highly concentrated alkaline solution, attracts very easily the colouring parts in the process of maddering. The case is not the same when the same earth is applied by the most highly concentrated acetic solution of alumine ; and it is absolutely impossible to finish maddering at one time, even when a profusion of madder is employed, and the operation is repeated three and even four times.* This circumstance will give rise to new and interesting experiments ; but my observations prove in the mean time that maddering, in general, requires to be managed with the nicest attention.

* Concentrated acetic solution of oxide of iron is attended with nearly the same difficulties.

No. 28.

*Description of an Improvement in Jury Masts. By Capt.* WILLIAM BOLTON, *of the Royal Navy.**

(With a Plate.)

SIR,

HEREWITH you will receive the model of a plan for fitting ships' jury masts, to be formed from the spare spars usually carried on board king's ships, and in every merchantman that is properly found. By having jury masts so fitted, ships will be enabled to carry as much sail as on the usual regular mast; the great use of which I need not dwell on, only observing that it may be of great importance to fleets after a general action, or when in want of proper lower masts, either at home or abroad, and enable ships, after the loss of their mast, to prosecute their voyage, or service, without any deficiency of sail.

I beg you will be pleased to lay it before the Society, and I have the honour to be,

Sir, your obedient humble servant,

WM. BOLTON.

Oct. 31, 1807.

C. TAYLOR, M. D. Sec.

REMARKS.

In the model in the Society's possession the main mast is broken about one-third of its length above the deck, proper partners are secured on the deck, in which a hand mast and a spare main top mast are fixed on each side of the broken main mast, and secured thereto by two spare caps, morticed on a square made in its centre. A strength-

* Tilloch, vol. 33, p. 346. From Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, for 1808.——The silver medal of the Society was voted to Capt. William Bolton for this communication.

*Bolton's improved Jury Mast with his mode of rigging it & setting up a ships lower rigging.*

ening cap, moveable on these additional masts, connects them, and the upper parts of these masts are secured firmly by trustle trees in the main top. The foot of a spare fore top mast passes through a cap made from strong plank, morticed into the heads of the two temporary masts above mentioned, goes through the main top, and rests in the moveable strengthening cap, which connects those two masts, and enables the fore top mast to be raised to any height which the main top will admit, and be then firmly secured by the upper cap, the main top, and the strengthening cap below it. The fore top mast being thus adjusted, the cross trees and top gallant mast are mounted upon it, which completes the whole business.

Two caps are the only things necessary to be made expressly for the purpose, the other articles being usually ready on board the ship.*

## No. 29.

### *Letter from Capt.* William Bolton, *of the Royal Navy, on his improved Jury Masts, and on a Contrivance for better securing the Shrouds of Ships.*†

(With a Plate.)

SIR,

Finding some doubts were entertained relative to the practicability of rigging jury masts, upon the plan I had

* The references to the Engraving in this communication are the same with those that are given at the end of the next paper by the same gentleman; they are therefore omitted here. Ed.

† Nicholson, vol. 25, p. 357. From Trans. of Soc. of Arts, vol. 27, p. 189. Some doubts having arisen as to the practicability of rigging Captain William Bolton's improved jury masts, described in vol. 26, page 167, of the Society's Transactions, (see preceding paper,) he in consequence has sent to the Society another model thereof completely rigged, which obviates all difficulty therein; and likewise has added another invention of his contrivance, for the better securing the shrouds of rigging; explanatory engravings of both are annexed, and the model is preserved in the Society's Repository. The gold medal of the Society was voted to Captain Bolton for his naval improvements.

the honour to present to the Society in Oct. 1807, I beg you will lay before them a model completely rigged; from which it will appear, that the rigging so placed will give, from the angle being more obtuse, greater security, and supersede the necessity of cathur pinning [catharpings], and admit of the lower yards bracing sharper up.

The hint which I gave formerly relating to striking a top mast is now carried into effect, by the mode in which I have fitted the top mast rigging, which admits of its being set up, almost instantaneously, at any point the mast shall descend to; the advantages of which are many, more particularly when the ships are riding hard in open roadsteads; for, by striking the top mast, ships will be enabled to ride much longer at their anchors, and still be ready to make sail on their top masts, according to the state of the weather, which will or ought to determine the distance to which the masts are struck.

In this model I also present to the Society a plan, the earliest of my mechanical pursuits, for setting up a ship's lower rigging, which will be effected by one man; whereas in the ordinary way it is performed by an assemblage of tackles, and the labour of a whole ship's company: the larboard side of the model is fitted up according to the old plan; the starboard side * with my improvement, which consists simply of a screw attached to each shroud, and tightened by a nut under the channels, which should be well secured by iron clamps or knees for this purpose: the expense will be far less than in the common mode; and I do think the bare inspection of the model will be sufficient to establish its superior efficacy.

I will thank you to expunge the passage from page

* The larboard side in fig. 4, of plate 5.

168 in the last volume, after the full stop at *main-top*,* and substitute the following:

"The spare fore top mast passes through a cap made from strong plank, *b*, into the square holes of which the heads of the two temporary masts above mentioned are inserted, and the heel of the top mast is fidded on the tressle trees or top as in common, and the mast rigged as usually. The object of the strengthening cap, G, is to steady the spars, and also serves to fid the top mast on, if thought necessary." I have the honour to be, &c.

WM. BOLTON.

## *Reference to the Drawing of Captain Bolton's Jury Mast, his Rigged Jury Mast, and his improved Mode of securing the Shrouds.*

Plate 5.—Fig. 1, 2, 3, 4, 5.

A A, fig. 4, represent the partners or pieces of timber, which are bolted to the quarterdeck for the mast to rest upon. B is the stump of the lower mast, which is cut square at the top, and of the same size as the head of the mast originally was; upon this square the main and spare lower caps *a a* are fixed; two mortices must be cut in the partners A A, to receive squares made at the lower ends of the two temporary masts D D, which are supported by the caps *a a*, one of them is a spare main top mast, the other a hand-mast; these two support the main top E, additional squares being made on the tressel trees to receive each of them. *b* is a cap shown in fig. 2, made of four-inch plank doubled for the purpose, and fitted upon the heads of the masts D D, for a fore top mast F F, the heel of which, when struck, rests in a mortice made in the stump of the lower mast; it is also steadied by a double cap G, separately shown in fig. 3,

* Emporium, p. 217, line 4 from the top.

on which it fids; as it does finally on the top. The top gallant mast H is fixed to the top mast F by the top and cap in the usual manner. The figures 2 and 3 show the caps separated from the masts, and are the only things necessary to be made for the purpose; and the object of the cap, fig. 3, is to steady and prevent any wringing of the lower jury mast, and to fid the top mast whenever it is reefed. The fore top mast F F, in fig. 1, appears in two separate pieces, on account of its length. In the proposed method of securing the shrouds of ships in general, I represents the screws with loop holes for the shrouds to be lashed to, and K the screw nuts, which by means of a proper wrench may be easily turned, so as to tighten or slacken the shrouds at pleasure. The other side of the ship is shown fitted up in the common way, that the contrast may be observed.

Fig. 1 is the jury mast unrigged, and fig. 5 is a side view of the mast and rigging, in which the same letters refer to the same parts.

## No. 30.

*Description of a Capstan, that works without requiring the Messenger or Cable coiled round it to be ever surged. By* J. WITLEY BOSWELL, *Esq. of Clifford's Inn.**

SIR—I request you will lay before the Society of Arts, &c. the model of a capstan contrived by me, which works without requiring the messenger or cable coiled round it to be ever surged, an operation necessary with common capstans, which is always attended with delay, and frequently with danger.

* Nicholson, vol. 21, p. 133. From Trans. of Soc. of Arts, vol. 25, p. 65 For this invention the gold medal was voted to Mr. Boswell.

Capstans of this kind can be made by a common shipwright, and would not be liable to be put out of order. They also would not occasion any additional friction or wear to the messenger or cable, in which particulars they would be superior to the other contrivance hitherto brought forward for the same purpose; they also would much facilitate the holding on.

The great loss of time and great trouble, which always attend applications to the Navy Board, prevent my attempting to bring the matter before the public through that channel, though I have had the most unequivocal approbation of the capstan from the two gentlemen of that board best qualified to judge of it. I mention this, lest it might be thought, that my not applying there first was from any doubt of the goodness of the invention. If the Society should approve of the capstan, I will draw up a more minute account of it for publication. I am, &c.

J. W. Boswell.

Sir—I have examined your model of a capstan, which is calculated to prevent the surging of the messenger when heaving in the cable; it certainly possesses great merit, and the idea to me is quite new. I am, &c.

*Nov.* 19, 1806. William Rule.

Sir—According to your desire, I transcribe the part of the letter from Mr. Peake (Surveyor of the Navy) to me, which relates to the capstan laid before the Society.

*Extract of a Letter from Henry Peake, Esq.*

"With regard to your ideas on the capstan; I have "tried all I can to find some objection to it, but confess "I hitherto have been foiled, and shall more readily "forward it, if it was only to supersede a plan now

"creeping into the service, more expensive, and much "worse than one lately exploded."

As you and the members of the Committee have seen the letter, I imagine further attestation needless relative to it.

I request you will mention, that all friction of the revolutions of the cable (or messenger) in passing each other between the barrels of the capstan, must be effectually prevented by the whole thickness of one of the rings that passes betwixt each crossing. I add this because one of the gentlemen of the Committee wished to be informed on this point. I am, &c.

J. W. Boswell.

Sir—In obedience to your intimation, that a written explanation of the advantages to be obtained by the use of capstans made according to the model, which I laid before the Society for the Encouragement of Arts, &c. would be acceptable, I send the following, which I hope will make the subject sufficiently clear.

As few but mariners understand the manner in which cables are hauled aboard in large ships, it will probably render the object of my capstan more manifest, to give some account of this operation.—Cables above a certain diameter are too inflexible, to admit of being coiled round a capstan; in ships where cables of so large dimensions are necessary, a smaller cable is employed for this purpose, which is called the *messenger,* the two ends of which are made fast together so as to form an endless rope, which, as the capstan is turned about, revolves round it in unceasing succession, passing on its course to the head of the ship, and again returning to the capstan. To this returning part of the messenger, the great cable is made fast by a number of small ropes, called nippers, placed at regular intervals; these nippers are applied, as

the cable enters the hawse hole, and are again removed as it approaches the capstan, after which it is lowered into the cable tier.

The messenger, or any other rope coiled round the capstan, must descend a space at every revolution, equal to the diameter of the rope or cable used; this circumstance brings the coils in a few turns to the bottom of the capstan, when it can no longer be turned round, till the coils are loosened and raised up to its other extremity, after which the motion proceeds as before. This operation of shifting the place of the coils of the messenger on the capstan, is called *surging the messenger:* It always causes considerable delay; and when the messenger chances to slip in changing its position, which sometimes happens, no small danger is incurred by those who are employed about the capstan.

The first method that I know of, used to prevent the necessity of surging, was by placing a horizontal roller beneath the messenger, where it first entered on the capstan, so supported by a frame, in which it turned on gudgeons, that the messenger in passing over it was compelled to force upwards all the coils above the capstan, as it formed a new coil.

This violent forcing of the coils upwards along the barrel of the capstan not only adds considerably to the labour in turning the capstan, but from the great friction which the messenger must suffer in the operation, while pressed so hard against the capstan, (as it must be by the weight of the anchor and strain of the men,) could not but cause a very great wear and injury to the messenger, or other cable wound round the capstan; and that this wear must occasion an expense of no small amount, must be manifest on considering the large sums which the smallest cables used for this purpose cost.

The next method applied to prevent surging was that

for which Mr. Plucknet obtained a patent, the specification of which may be seen in the Repertory of Arts, No. 46. In this way a number of upright puppets or lifters, placed round the capstan, were made to rise in succession, as the capstan turned round, by a circular inclined plane placed beneath them, over which their lower extremities moved on friction wheels; and these puppets, as they rose, forced upwards the coils of the messenger on the barrel of the capstan.

This was a superior method to the first, as the operation of forcing upward the coils was performed more gradually by it; but still the wear of the messeuger from the lateral friction in rising against the whelps of the capstan remained undiminished.

The third method used for the same purpose was that proposed by captain Hamilton. It consisted in giving the capstan a conical shape, with an angle so obtuse, that the strain of the messenger forced the coils to ascend along the sloped sides of the barrel. The roller first mentioned was sometimes used with this capstan, of which a full account is inserted in the Repertory of Arts, vol. 2.

The lateral friction, and wear of the messenger against the whelps of the capstan, are equally great in this method as in the others; and it, besides, has the inconvenience of causing the coils to become loose as they ascend; for as the upper part of the barrel is near a third less in diameter than the lower part, the round of the messenger, that tightly embraced the lower part, must exceed the circumference of the upper extremity in the same proportion.

In the method of preventing the necessity of surging, which the model I have had the honour of laying before the Society represents, none of the lateral friction of the messenger or cable against the whelps of the capstan,

(which all the other methods of effecting the same purpose before mentioned labour under,) can possibly take place, and of course the wear of the messenger occasioned thereby will be entirely avoided in it, while it performs its purpose more smoothly, equally, and with a less moving power than any of them.

My method of preventing the necessity of surging consists in the simple addition of a second smaller barrel or capstan of less dimensions to the large one; beside which it is to be placed in a similar manner, and which need not in general exceed the size of a half-barrel cask. The coils of the messenger are to be passed alternately round the large capstan and this small barrel, but with their direction reversed on the different barrels, so that they may cross each other in the interval between the barrels, in order that they may have the more extensive contact with, and better gripe on each barrel. To keep the coils distinct, and prevent their touching each other in passing from one barrel to the other, projecting rings are fastened round each barrel, at a distance from each other equal to about two diameters of the messenger and the thickness of the ring. These rings should be so fixed on the two barrels, that those on one barrel should be exactly opposite the middle of the intervals between those on the other barrel: and this is the only circumstance, which requires any particular attention in the construction of this capstan. The rings should project about as much as the cable or messenger from the barrels, which may be formed with whelps, and in every other respect, not before mentioned, in the usual manner for capstan barrels, only that I would recommend the whelps to be formed without any inclination inwards at the top, but to stand upright all round, so as to form the body of the capstan in the shape of a polygonal prism, if the intervals between the whelps are filled up, in order that the coils

may have equal tension at the top and at the bottom of the barrels, and that the defect which conical barrels cause in this respect may be avoided.

The small barrel should be furnished with falling palls as well as the large one; a fixed iron spindle ascending from the deck will be the best for it, as it will take up less room. The spindle may be secured below the deck, so as to bear any strain, as the small barrel need not be much above half the height of the large barrel; the capstan bars can easily pass over it in heaving round, when it is thought fit to use capstan bars on the same deck with the small barrel. As two turns of the messenger round both barrels will be at least equivalent to three turns round the common capstan, it will hardly ever be necessary to use more than four turns round the two barrels.

The circumstance which prevents the lateral friction of the messenger in my double capstan is, that in it each coil is kept distinct from the rest, and must pass on to the second barrel, before it can gain the next elevation on the first, by which no one coil can have any influence in raising or depressing another; and what each separate coil descends in a single revolution, it regains as much as is necessary in its passage between the barrels, where in the air, and free from all contact with any part of the apparatus, it attains higher elevation without a possibility of friction or wear.

I have described my double capstan, as it is to be used in large vessels, where messengers are necessary, from the great size of the cables; but it is obvious that it is equally applicable in smaller vessels, as their cables can be managed with it in the same manner as is directed for the messenger. The same principle may also be easily applied to windlasses, by having a small horizontal barrel placed parallel to the body of the windlass, and

having both fitted with rings, in the same way as the capstan already described. The proper place for the small horizontal barrel is forward, just before the windlass, and as much below its level as circumstances will admit; it should be furnished with catch-palls as well as the windlass.

Beside the advantages already stated, my proposed improvement to the capstan has others of considerable utility. Its construction is so very simple, that it is no more liable to derangement or injury than the capstan itself. Its cost can be but small, and every part of it can be made by a common ship carpenter, and be repaired by him at sea if damaged by shot. It will take up but little room, only that of a half barrel cask; and it is of a nature so analogous to that kind of machinery, to which sailors are accustomed, that it can be readily understood and managed by them.

In order to render the description of my double capstan more clear, I annex a sketch of it, as fitted up in the manner proposed. I am, &c.

J. Witley Boswell.

### *Reference to the Engraving of Mr. Boswell's improved Capstan, to prevent the necessity of surging.*

Plate 6, Fig. 1.

A represents the larger or common capstan used on board ships.

B another capstan of less dimensions, placed in a similar manner.

C the coils of the messenger passing alternately round the large and small capstans, but with their direction reversed on the different barrels, so that they may cross each other in the interval between them.

D D D D projecting rings round each capstan or bar-

rel, so fixed on the two barrels, that those on one barrel should be exactly opposite the middle of the intervals between those on the other barrel.

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## No. 31.

### *A brief Account of the Manufacture of Gilt Buttons, comprising some Improvements important to Manufacturers. Communicated by Messrs.* Collard *and* Frazer, *of Birmingham.**

(With a Plate.)

As the means employed in the manufacture of plain gilt buttons are not universally known, the following summary, while it points out to the manufacturer many considerable advantages, in the use and recovery of his mercury, will also, it is hoped, be found interesting to many readers of the Philosophical Magazine.

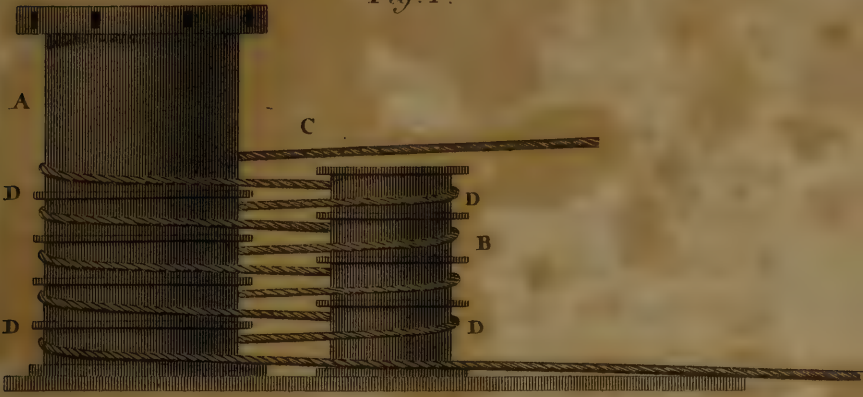
The copper, properly alloyed, is first taken to a rolling mill, and reduced between iron rollers to a proper thickness for the button. The sheets of copper are then brought to the button manufactory, and cut into circular pieces of the size of the intended button by means of a fly-press. In this state they are called *blanks,* and resemble halfpence and farthings worn smooth by long circulation.

The shanks, which are made with wonderful facility and expedition by means of a very curious machine, are then secured to the bottom of each button by a small iron crank, and a small quantity of solder and rosin applied to each. Thus they are placed on a sheet of iron, containing about a gross, and introduced into a very hot

* Tilloch, vol. 9, p. 15.

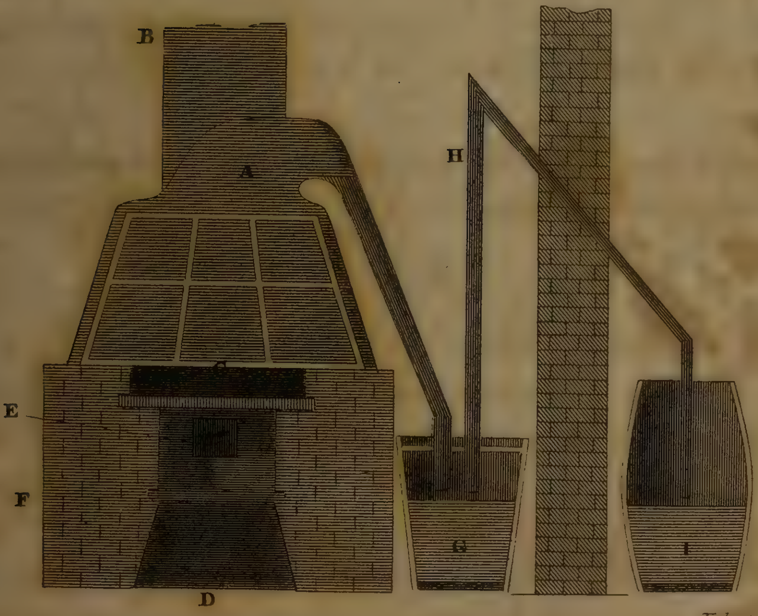
## *Boswell's Improved Capstan.*

*Fig. 1.*




## *Manufacture of Gilt Buttons.*

*Fig. 2.*



stove, where they remain till the workman is satisfied that the solder has melted, and that the shanks are united to the button; after which the edges are smoothed in a lathe.

The next process is what they call *dipping;* that is, a quantity, consisting of a few dozens, is put into an earthen vessel full of small holes like a cullender, and thus dipped into diluted nitric acid to clean them from dirt and rust. They then, according to the best practice, go into the hands of the burnisher, who, in a lathe, burnishes the tops, bottoms, and edges, with a hard black stone, got from Derbyshire, secured in a handle like the diamond of a glazier: this he applies to the button fixed in the end of a piece of wood, turned with great velocity by means of a treddle with which he works the lathe. This is called *rough burnishing*, and is a modern improvement: it is of great advantage, for it closes the pores of the metal opened by the acid, so that the gold afterwards to be applied attaches to a smooth surface, which otherwise might enter into imperceptible cavities, and be closed up in the body of the button by the final burnishing. When the buttons come from the burnisher they are fit for gilding. This is a very curious operation, and truly chemical.

The first process towards gilding is what they call *quicking,* which is effected as follows:—Any given quantity of buttons, perhaps a gross, is put into an earthen vessel with a quantity of mercury which has been previously saturated with nitric acid; and thus the buttons and mercury are stirred together with a brush till the mercury, carried by the affinity of the acid to the copper, adheres to the whole surface of the button. The buttons are then taken out and put into what is called a *basket,* though in fact an earthen vessel full of small holes, the handle of which the operator holds in his

hand, and jerks it with considerable force down towards a wooden trough (a receptacle for the quicksilver) till, by repeated jerks, all the loose particles of mercury are disengaged, leaving a complete continuity over the surface, and giving them the appearance of silver buttons.

Now the gold, a grain of which will spread over many superficial feet of copper, is thus prepared: Any given quantity of mercury is poured into an iron ladle, the inside of which having been previously *guarded,*—that is, rubbed over with dry whiting to prevent the gold from adhering to the iron,—into this mercury is thrown the portion of pure gold intended to cover a given quantity of buttons. The gold and mercury are heated together in the iron ladle till the workman (whose practice soon enables him to judge) perceives that there is a perfect union between them; when he empties his ladle into a vessel containing cold water.

The amalgam being cold, is put into a piece of shammoy leather, and squeezed till no more mercury will pass through. What passes the shammoy contains not the smallest portion of gold; what remains will be about the consistency of butter, so completely united that every particle of mercury shall contain an equal portion of gold. The amalgam should be then put into an earthen vessel, and a small quantity of nitric acid added thereto, allowing sufficient time for the acid to unite with the mercury. But the buttons and amalgam are commonly introduced first, and a quantity of diluted nitric acid added thereto, so that, for want of a complete union between the mercury and acid first, if there be not a superabundancy of acid, there may not be sufficient to carry all the amalgam to the surface of the buttons.

When the acid has had sufficient time to *embrace* (as workmen call it) the mercury, the buttons should be introduced, and be stirred till the amalgam, carried by the

affinity of the acid to the copper, and the tendency which the gold has to extend itself to the mercury with which the buttons have been previously quicked, completely attaches to the whole surface.

It is the next process in which we principally wish to recommend a deviation from the old practice, by which most of the mercury will be recovered, and the gilder's health, in a great measure, preserved from the dreadful effects of volatilised mercury.

The old practice is as follows: The buttons being completely covered with mercury and gold, the operator proceeds to that business which is called *drying-off*, which is performed thus: The buttons, to the quantity of a few dozens, are put into an iron pan somewhat like a large frying-pan, placed over a fire, and gently shook, while the operator watches carefully till he observes the mercury begin to flow;—upon the first symptom of which, he takes the pan from the fire, and throws the buttons into a large cap, called a *gilding cap*, like a man's hat with a very small brim, but much larger in the crown, made of coarse wool and goats hair. In this cap, with a circular brush, the buttons are stirred, to spread the gold and mercury while in a degree of temperature nearly sufficient to volatilise the mercury. The buttons are again thrown into the pan, placed over the fire, and shaken, while the mercury gently volatilises. The buttons are again thrown into the cap, and stirred with the brush. This process is continually repeated, till all the mercury is volatilised, leaving the gold on the buttons, which appear again of a yellow colour.

Thus a principal part of the mercury ascends the chimneys, is deposited on the tops of the houses and about the adjacent neighbourhood, and great quantities are inhaled and absorbed by the operator, keeping him

nearly in a state of salivation till disease obliges him to desist.

Considerable quantities of mercury thus volatilised are found united and collected in small pools in the spouts and gutters on the tops of the buildings. Thus many tons of mercury have been dissipated about the town and neighbourhood of Birmingham, to the great injury of the inhabitants. The poor sweep who has ascended the chimneys has been salivated, and the manufacturer has sustained considerable loss.

To preserve a principal part of the mercury thus dissipated, and to prevent, in a great measure, the terrible effects of it on the constitution of the operator, is the object of these remarks, as far as it regards manufacturers.

By means of an apparatus similar to the plan delineated in Plate 6, fig. 2, which has been partially and successfully adopted by Mr. Mark Sanders, an eminent button-maker of Birmingham, the principal part of the mercury may be recovered, and the health of the operator greatly preserved.

A hearth of the usual height is to be erected, in the middle of which a capacity for the fire is to be made; but instead of permitting the smoke to ascend into the top A, made of sheet or cast iron, through which the mercury is volatilised, a flue for that purpose should be conducted backwards to the chimney B. An iron plate, thick enough to contain heat sufficient to volatilise the mercury, is to cover the fire-place at the top of the hearth C. There must be an ash-hole, D, under the fire-place. The square space E, seen in the fire-place, is the flue, which serves to carry the smoke back under the hearth into the chimney B. The door of the fire-place and ash-pit may either be in front, as represented in the plate, or at the end of the hearth at F, which will perhaps less incommode the work-people. It would be of great advantage

if the space between A and the iron plate C was covered up with a glass window coming down so low as only to leave sufficient room for moving the pan backwards and forwards with facility. If the sides were also glass instead of brick-work it would be still better, as the work-people would be able to have a full view of their work without being exposed to the fumes of the mercury, which, when volatilised by heat communicated to the pan by the heated iron plate over the fire-place, would ascend into the top A, appropriated for its reception, and descend into the tub G, covered at top and filled pretty high with water. By this means the hearth would, in fact, become a distilling apparatus for condensing and recovering the volatilised mercury. In the tub G the principal part would be recovered; for, of what may still pass on, a part would be condensed in ascending the tube H, and fall back, while the remainder would be effectually caught in the tub or cask I, open at the top and partly filled with water. The latter tub should be on the outside of the building, and the descending branch of the tube H should go down into it at least 18 inches, but not into the water. The chimney or the ash-pit should be furnished with a damper to regulate the heat of the rfie.

The water may be occasionally drawn out of the tubs by a siphon, and the mercury clogged with heterogeneous matter may be triturated in a piece of flannel till it passes through, or placed in a pan of sheet iron, like a dripping-pan, in a sufficient degree of heat, giving it a tolerable inclination, so that the mercury, as it gets warm, may run down and unite in the lower part of the pan. But the mercury will be most effectually recovered by exposing the residuum left in the flannel bag to distillation in a retort made of iron or of earthenware.

When the mercury is volatilised from the buttons, or,

as the workmen denominate it, when the buttons are dried off, they are finally burnished, and are then finished and fit for carding.

The reader unacquainted with this branch of manufacture will be surprised to learn how far a small quantity of gold, incorporated with mercury, will spread over a smooth surface of copper. Five grains, worth one shilling and threepence, on the top of a gross, that is, 144 buttons, each of one inch diameter, are sufficient to excuse the manufacturer from the penalty inflicted by an act of parliament; yet many, upon an assay, are found to be deficient of this small quantity, and the maker fined and the buttons forfeited accordingly. Many hundred grosses have been tolerably gilt with half that quantity; so extremely far can gold be spread, when incorporated with mercury, over the surface of a smooth piece of copper.

## No. 32.

### *List of American Patents.*

(Continued from page 157.)

1795.

Jacob Perkins, Jan. 16, machine for cutting nails.

Samuel Mulliken, Jan. 15, improvement in the mode of breaking flax and hemp.

Samuel Kellogg, Jan. 31, improvement in shearing woollen and other cloths.

Josiah G. Peerson, March 23, machine for cutting nails.

Joseph Ellicott, March 25, new mode of catching fish.

S. Morey, March 25, improvement in the application of steam.

John Youle, May 25, construction of a caboose.

J. Pitman, May 25, improvement in the manufacturing of cordage.

Daniel Keller, May 25, improvement in propelling boats.

W. P. Sprague, June 19, propelling boats, &c. with horses.

Benjamin Wynkoop, June 19, nautical ventilators.

John Taylor, June 30, tinned sheet copper condensing worm.

1796.

Jared Byington, Jan. 15, improvement in making nails.

Jonathan Dickerson, Jan. 9, improvement in sawing and polishing marble, &c.

James Eaton, Feb. 12, manufacturing seal skins.

E. Perkins, Feb. 19, removing pains, &c. by metallic points.

Samuel Movey, April 11, raising water by wind.

Benjamin Tyler, April 15, machine for cleaning wheat, &c. &c.

James Davis, April 14, improvement in tanning leather.

T. Bidwell, April 20, improved mode of forming a yellow colour

Samuel Lee, jun. April 30, composition of "bilious pills."

Peter Zacharie, May 4, machine for cutting nails and brads.

J. Hilyard, May 12, improvement in manufacturing sumach.

Robert Dawson, May 12, improvement in bolting cloths.

Hodgen Holmes, May 12, improvement in the cotton gin.

J. Roberts, jun. Feb. 13, cleaning clover and other seeds, &c.

James Sylvanus M'Lean, May 27, improvement in piano fortes.

Oliver Evans, May 28, improvement in burr mill-stones.

Elijah Backus, May 31, new invented steam engine and boiler.

L. M'Kechnie, July 1, stays for removing distortions in the spine.

Joseph Francis Mangin, July 2, improvement in sawing and polishing marble, &c.

Robert Grant, Oct. 17, machine for scouring rice and other grain.

George James, Nov. 16, improvement in making salt.

John Fowler, Nov. 16, improvement in concentrating the volatile parts of calcareous earth, stones, &c.

Peter Cliff, Nov. 16, improvement in manufacturing cut nails.

Isaac Garretson, Nov. 16, machine for heading and cutting nails.

Apollos Kinsley, Nov. 16, improvement in a printing press.

James Stanfield, Nov. 16, improvement in splitting sheep skins.

Mark I. Brunel, Nov. 16, new method of ruling books and paper.

Theobald Bourke, Nov. 16, improvement in pumps.

William Frobisher, Nov. 17, manufacturing potash.

Clement Rentgen, Nov. 17, improvement in forging bolts and round iron.

Amos Whittemore, Nov. 17, improvement in a loom for weaving cloth.

Amos Whittemore, Nov. 19, a "preambulator" for measuring a ship's way.

Amos Whittemore, Nov. 19, machine for cutting nails.

John Bigelow, Nov. 19, improvement in manufacturing nails.

George Chandlee, Dec. 12, improvement in cutting and heading nails, &c.

Thomas Passmore, Dec. 23, conjuror for cooking and boiling.

D. French, Dec. 23, improvement in manufacturing cut nails.

D. French, Dec. 23, improvement in manufacturing wrought nails.

Jared Byington, Dec. 23, improvement in heading nails.

Jason Frost, Dec. 23, improvement in heading nails.

James Dellet, Dec. 23, machine for separating scoured rice.

Robert Watkins, Dec. 23, improvement in ginning cotton.

John Murray, Dec. 23, improvement in ginning cotton.

1797.

John Nazro, Jan. 6, improvement in making soap.

John Nazro, Jan. 6, extracting alkali from marine salt and kelp.

Charles Wilson Peale, Jan. 21, improvement in bridges.

J. Spence, Feb. 16, improvement in cutting and heading nails.

Joseph F. Mangin, Feb. 16, improvement in cutting and polishing marble, &c.

James M'Callmont, Feb. 20, improvement in stoves.

S. Mulliken, Feb. 20, improvement in scouring or skinning rice.

Richard Stuart, Feb. 24, improvement in chimneys.

John Fowler, Feb. 24, improvement in bridges.

Jesse Kersey, Feb. 24, improvement in cutting and heading nails.

L. Allwine, Feb. 24, improvement in mixing colours and painting.

Thomas Hirst, March 11, improvement in stoves.

William Booker, March 11, machine for threshing wheat, &c.

Silas Betts, March 18, improvement in a tide-water wheel.

Nathaniel Briggs, March 18, improvement in washing clothes.

Caleb Wheaton, March 29, improvement in stoves.

Jesse Kersey, April 13, improvement in fire engines.

Caleb Leach, April 13, improvement in boring pumps.

Fitch Hall, April 17, combination of astringent woods and vegetables in distilling, &c.

Jehoshaphat Starr, April 28, improvement in propelling boats and vessels, by steam engines.

William Faris, April 29, improvement in propelling carriages.

Benjamin Duval, May 3, antibilious pills.

Isaac Garretson, May 29, improvement in constructing and rigging vessels.

Amos Whittemore, June 5, improvement in manufacturing wool cards, &c.

David Grieve, June 8, improvement in looms.

Walter Burt, June 23, raising a nap on cloths.

Benjamin Seymour, June 26, rollers for slitting and other mills for rolling iron.

B. Seymour, June 26, improvement in straightening iron hoops.

B. Wynkoop, June 26, pendulous bellows, for pumping ships.
Joseph S. Sampson, June 26, improvement in making candles.
Charles Newbold, June 26, improvement in ploughs.
Moses Johnson, June 30, mode of preserving butter.
J. Hawkins, July 11, improvement in forming bricks, tiles, &c.
Thomas Bruff, July 1, improvement in extracting teeth.
Bill Jarvis, July 8, improvement in making shingles, boards, &c.
Apollos Kinsley, August 12, improvement in cutting tobacco.
J. Nevil, Aug. 12, improvement in cutting and heading nails.
Henry Dulheur, August 18, improvement in saw-mills.
Jonathan W. Curtis, August 24, improvement in mills.
Charles W. Peale, Nov. 16, improvement in fire-places.
Thomas Stickney, Nov. 16, improvement in saddles.
Daniel Pettibone, Nov. 16, improvement in breaking dough and paste.
Richard R. Eliot, Nov. 16, improvement in threshing grain.
Eli Terry, Nov. 17, improvement in clocks, time-keepers, and watches.
Stephen Parsons, Nov. 20, improvement in making sashes.
John Martin, Nov. 21, machine for propelling boats.
Timothy Palmer, Dec. 17, improvement in bridges.
Elias Ring, Dec. 10, a spiral wheel for working in tide-water.
William Payne, Dec. 10, a soap-stone stove.
Lester Fling, Dec. 19, improvement in making nails.

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*List of English Patents.**

1796.

William Desmond, Jan. 15; for a method or process of tanning all sorts of hides and skins, and of rendering more solid and incorruptible, in water, several vegetable and animal substances, such as flax, hemp, spartery, cotton, silk, hair, wool, &c. as well as the materials made thereof.

Isaac Wheildon, and John Bowler, April 26; for a new method of making and working presses for packing goods.

William Goldfinch, May 24; for the invention of an improved truss for the cure and prevention of ruptures.

Joseph Stacey Sampson, May 24; for the invention of an art or method of cutting up tallow-fat, spermaceti, and wax, for melting; and of making the same into candles.

John Strong, May 31; for the invention of certain new improve-

* Repertory, vol. 7.

ments in the construction of piston-cylinders, suction-chambers, and valves, whereby the same may be more expeditiously repaired.

John Howell, May 31; for an improved engine or machine for the purpose of boring or hollowing wooden water-pipes, or aqueducts, in a much more expeditious manner than hitherto practised, and whereby a considerable saving will be made in timber.

William Booth, May 31; for the invention of an improvement in making stays and corsets.

William Law, May 31; for certain new improvements in and upon water-closets.

Edward Haskew, May 31; for an engine for raising earth from the bottom of canals, or any other place of depth, to the surface of the earth.

John Pepper, June 9; for the invention of a certain kiln, for drying malt, or other grain.

James Keeling, June 20; for a substitute for white-lead, red-lead, or any other preparation of lead, in glazing and enamelling all manner of earthen and China wares, &c.

William Whittington, June 28; for a portable baking-stove.

William Bundy, June 28; for a machine for cutting and making combs.

James Parker, June 28; for a cement or terras, to be used in aquatic and other buildings, and stucco work.

John Ching, June 28; for a medicine for destroying worms.

Robert Miller, June 28; for a method of weaving all kinds of linen, cotton, woollen, and worsted cloths, by looms wrought by water, steam-engines, horses, or any other power.

William Batley, June 28; for an improveement in the working of steam-engines.

Daniel Davis, July 4; for an apparatus or machinery for cleansing or sweeping of chimneys, and extinguishing them when on fire, without sending any person up the chimney.

William Sabatier, July 4; for a method of retaining cotton, hemp, flax, hops, hay, and other articles, in nearly the same compass in which they can be compressed.

## INTELLIGENCE.

### *Etching on Glass with Fluoric Acid.*

The Editor has great pleasure in presenting to the public a small landscape from an etching on glass with fluoric acid, one of the constituents of the ornamental Derbyshire spar. This engrav-

Etched on glass with Fluoric Acid.

Coxe

ing is not to be viewed with the eye of fastidious criticism; although in itself it is by no means an indifferent performance, yet its merit arises from its singularity. Probably, not one hundred persons in the United States have ever had an opportunity of seeing a similar production. The great difficulty of passing the glass through the press of the copper-plate printer, without breaking it, which, in common with others, the Editor has experienced, has always prevented this species of engraving from being extended beyond the etching itself. The only plate which is known to the Editor as successfully accomplished, is a frontispiece to the 3d London edition of Parke's Chemical Catechism. It is scarcely more than a bare outline of some of the apparatus of chemical scienee; and, although so rudely executed, as to bear no comparison with the present, yet Mr. Parke says of it, " I have reason to believe it exhibits a more favourable specimen of printing from glass, etched by fluoric acid, than any that has hitherto been produced." (p. 233.)

The Editor is much indebted to the assistance of Mr. Tiebout whose excellence as an engraver is well known; but he is more especially so to the patience and perseverance of Mr. Duffy, (copper-plate printer, with Mr. Dainty, of this city,) by whose co-operation the plate has been so successfully printed. The difficulty may be appreciated, when it is stated, that after seven hundred plates had been taken off, the glass was unfortunately broken, and the design of giving it to the public was nearly suspended. The uncommon patronage however which the Emporium has already received, called for every exertion on the part of the Editor; and he accordingly executed another etching from the former, from which the remaining plates have been taken; and in a way, which experience leads him to hope, will facilitate any future attempts of this nature.

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*Intelligence and Miscellaneous Articles; including Memoranda, Hints, Precepts, and Recipes, for the use of Artists, Manufacturers, and others.*

Mr. Carnot in his new treatise on the defence of fortified places, recommends the besieged to fire howitzers wadded with grape shot or musket ball, at an elevation of 45 degrees, when the enemy have made their approaches to within a certain distance, which may be effected without their being exposed, and the shot will do more execution, not being stopped by the enemy's works. Mr. Carnot's suggestion has been adopted in France, and now forms part of the artillery exercise. *Tilloch, No.* 159.

Mr. Henz, an eminent tanner at Srzensk, in Poland, has ascertained that the leaves of the oak may be advantageously substituted for the bark, in tanning leather, provided they are used in the month of September, when they possess the bitter sap which they afterwards lose. *Tilloch, No.* 159.

To make a common watch into a nocturnal one, Mr. E. Walker of London, " made notches with a file in the rim of its inner case, against every hour upon the dial, except 3, 6, 9, and 12. These tangible marks are made no deeper than just to receive the nail of the finger or thumb, as it is drawn over them. The hour of 12 is known by the pendant, and little pins are fixed into the case at the hours of 3, 6, and 9, projecting outwards about one-twetieth of an inch, to distinguish those hours from the rest.

To ascertain the time in the dark by this watch, open the glass, and feel with the finger the situation of the hour hand, and correct the tangible marks, beginning at 3, 6, 9, or 12, to find the hour; and by the same means the minutes are found.

Mr. W. considers it as giving the time with more precision than a repeater, and without disturbing the repose of any person near it. *Tilloch, No.* 167.

### PREPARATION OF BRUNSWICK GREEX.

Kasteleyn has lately published the following method of preparing this colour, which is much used on the Continent for oil painting, and in the manufacturing of printed paper. Shavings of copper are put into a close vessel, and besprinkled with a solution of the muriat of ammonia. The metal first unites with the muriatic acid, and is dissolved, and is in its turn precipitated by the disengaged ammonia, to which it now joins itself. The precipitate is then washed and dried in wooden boxes, or upon an extended cloth. The liquid which remains, as well as the water of the first washing, may be employed several times in succession for new operations, by dissolving in it fresh portions of sal ammoniac to the point of saturation. Three parts of the muriat of ammonia are sufficient for two parts of copper, and the result is six parts of colour. This beautiful green is in Holland called Friesland green. It is almost always adulterated with ceruse. *Tilloch, vol.* 4.

### CEMENT FOR FILLING UP CRACKS AND FISSURES IN IRON VESSELS.

The same author has also made known this cement. It consists of six parts of yellow potter's clay, one part of the filings of iron, and a quantity of linseed oil sufficient to form the whole into a paste of the consistence of putty. *Tilloch, vol.* 4.

THE

# EMPORIUM

OF

ARTS AND SCIENCES.

VOL. 1.] AUGUST, 1812. [No. 4.

## No. 33.

## ON SPONTANEOUS COMBUSTION.

(Continued from page 178.)

*On Spontaneous Inflammations. By* C. BARTHOLDI, *Professor of Natural Philosophy and Chemistry* *.

THE name of spontaneous inflammation is given to that manifested in a combustible body, without its being in immediate contact with a body in a state of inflammation.

Combustion of this kind may be occasioned by different causes, the principal of which are:

1st, Violent friction.

2d, Action of the sun.

3d, The disengagement of the caloric produced in bodies though not combustible, but brought near to combustible bodies, to which they may communicate such a degree of heat that they inflame by the contact of the air.

4th, The fermentation of animal and vegetable substances heaped up in a large mass, which are neither too dry nor too moist, as hay, dung, &c.

* Tilloch. v. 18, p. 346: from the *Annales de Chimie*, No. 144.

5th, the accumulation of wool, cotton, and other animal and vegetable substances, covered with an oily matter, and particularly a drying oil.

6th, The boiling of linseed oil for printers ink, of varnish, and in general of every fat matter.

7th, The torrefaction of different vegetable substances.

8th, Sulphurized and phosphorized hydrogen gas disengaged in several operations of nature, the last of which in particular inflames merely by the contact of the atmospheric air even at a low temperature, and which often presents itself at the surface of the earth like a small flame, known under the name of *will-with-the-wisp*, in places where animal substances in a state of putrefaction have been buried: if there are other combustibles at that time on the spot where the disengagement takes place, they may readily be kindled.

9th, Phosphuret of lime and of potash which may be formed in the preparation of charcoal, especially in that of turf and some sorts of wood which grow in marshy places. This charcoal, when wet, or by merely attracting the moisture of the atmosphere, forms phosphorated hydrogen, which by the contact of the atmospheric air inflames, and may set fire to the whole mass of charcoal.

10th, The phosphorus which is sometimes formed, though rarely, in the carbonization of different kinds of wood, without being combined either with lime or potash in the state of phosphuret. This charcoal does not inflame spontaneously at the common temperature of the air; but it may produce a detonation when struck with nitrate of potash, or some other nitrates or metallic oxides to which oxygen weakly adheres, and which are found in a state of thermoxide retaining a great deal of latent caloric.

### 1. *Friction.*

It is generally known that two bodies when rubbed against each other become heated. The intensity of the

heat produced depends on several circumstances, and varies chiefly in the ratio of the duration of the friction, and of the nature and surface of the rubbed bodies. If the friction takes place between combustible bodies, such as wood, the heat it excites may often be sufficient to inflame it; if the bodies are not combustible, such as stones, or little combustible, as metals, they do not inflame themselves; but they may communicate to other combustible bodies around them such a degree of heat that the latter will inflame by contact with the atmospheric air.

D. Palcani repeated the experiments long known for obtaining fire by the friction of two pieces of wood, giving to one of the rubbing pieces the form of a tablet, and to the other that of a spindle or cylinder: the result of some of these experiments will be sufficient to show, that, in the construction of machines and instruments, more attention ought to be paid to the choice of the wood destined to be exposed to mutual friction.

| Cylinders. | Tablet. | Duration. | Effect. |
|---|---|---|---|
| Box wood | Box | 5 min. | Sensible heat. |
| Ditto | Poplar | Ditto | Ditto |
| Ditto | Oak | Ditto | Ditto |
| Ditto | Mulberry | 3 | Considerable heat and smoke |
| Ditto | Laurel | Ditto | Ditto |
| Laurel | Poplar | 2 | Ditto |
| Ditto | Ivy | Ditto | Ditto |
| Ivy | Box | 3 | Ditto |
| Ditto | Walnut | Ditto | Ditto |
| Olive | Olive | Ditto | Ditto |
| Mulberry | Laurel | 2 | Consid. heat, smoke, and blackness |
| Ash | Oak | 5 | Sensible heat |
| Ditto | Fir | Ditto | Ditto |
| Pear-tree | Oak | Ditto | Ditto |
| Cherry | Elm | Ditto | Ditto |
| Plum | Apple-tree | Ditto | Ditto |
| Oak | Fir | Ditto | Ditto |

Changing the experiment, and rubbing a cylinder of one of the kinds of wood between two tablets of the other, a cylinder of poplar for example between two tablets of mulberry wood, the increase of the rubbed surfaces which are in contact with the air produced a heat much more considerable, and almost the whole of the kinds of wood above enumerated took fire.

The effect of friction still varies according as the woods employed, especially if they are of the same kind, are rubbed in the direction of the fibres, or when the fibres cross each other. In the first case, the friction and heat are much more considerable than in the second.

In large machines where there is much friction, heating may be prevented by continually directing a current of cold water on the rubbing surfaces: in common machines, carriages, &c. it is diminished by covering the surfaces with an oily matter. There are many instances, during the great heats in summer, of carriages and other machines exposed to violent motion inflaming, because care has not been taken to grease them. Grease, by hardening on the rubbing surfaces, instead of lessening the friction increases it; and as this covering is highly combustible, it renders spontaneous inflammation more easy. In many cases, therefore, it is better to rub the machines with soap, talc, plumbago, or other substances, which without being oily are very unctuous to the touch.

### 2. *Action of the Sun.*

The strongest heat is produced, all sorts of combustibles are kindled, and the most refractory substances are fused by exposure to the sun's rays concentrated by means of lenses or concave mirrors. It may happen that other bodies are in such a condition as to produce without our will the effects of lenses and of burning mirrors: though these effects are rather physical than chemical, it is of

importance to make them known, in order to guard against the danger of them. We have instances of fires produced by glass decanters filled with water and exposed to the sun in an apartment. When the form of the vessel is nearly similar to that of a lenticular or spherical glass, the rays are refracted, and produce, by uniting in the focus, a heat capable of setting fire to combustible bodies placed in it.

### 3. *Heat excited in non-combustible bodies.*

It is well known that quicklime immersed in water, or merely moistened, produces a considerable degree of heat. It has even been employed with success for heating at a small expense apartments, hot-houses, hot-beds, &c. This property which quicklime has of disengaging a great deal of caloric by contact with the air, and that no less dangerous of dissolving and corroding animal substances immersed in it, require the greatest precautions where considerable depots of quicklime are formed. To preserve it, care must be taken to guard it from the contact of the air, and from moisture of every kind; and particularly to remove from its neighbourhood all combustible bodies, such as wood, hay, straw, &c., which might inflame spontaneously should the lime contract the least humidity. The *Journal de la Houte-Saône* gave an account last year of the burning of a barn, one of the partitions of which being wood had caught fire, because a heap of quicklime, intended for repairing the farm-houses, had been carelessly thrown against it.

A great number of similar phænomena take place in nature, where bodies, by changing their composition, or contracting new combinations, become so heated, or disengage so much caloric, that other combustible substances around them may be inflamed.

### 4. *Fermentation of Animal and Vegetable Substances.*

Most animal and vegetable substances, if heaped upon each other while they still retain their moisture, enter into fermentation; a change is effected in their composition, and they often become so much heated as to inflame. In this manner, haystacks, turf, flax, hemp, straw, and heaps of rags in paper manufactories, take fire.

The principal precautions ought to be employed in regard to hay: if cut in a rainy season, it is generally stacked before it is completely dry, and in this state it is the more disposed to ferment and become hot. As soon as a stack of hay is observed to be in a state of fermentation, care must be taken not to throw it down too speedily. The exterior strata ought to be slowly detached one after the other. When an opening is made in the middle of a heated mass of hay, it almost always happens that the fire suddenly bursts forth.

Nothing, however, is easier than to prevent such fatal accidents. When it is apprehended that hay about to be stacked is not completely dry, it will be sufficient to strew over each stratum a few handfuls of muriate of soda (common salt). The expense in this case ought to be a consideration of no importance; for the salt, by absorbing the moisture of the hay, not only prevents its fermentation, and the inflammation which thence results, but it adds also to the hay a savour which excites the appetite of the cattle, assists their digestion, and preserves them from a great many diseases.

During the great heats of summer it often happens that heaps of dung inflame spontaneously. Great care therefore must be taken to water dunghills from time to time, and to keep them at a certain distance from houses, both to prevent fires and for the sake of salubrity.

### 5. *The Accumulation of Animal and Vegetable Substances covered with Oil.*

If animal and vegetable substances heaped up in a large mass can be inflamed in consequence of the heat produced by their decomposition, this accident is more to be apprehended when they are covered with oily matters, and especially a drying oil.

Besides the accident which happened at the manufactory of Lagelbart, and of which my colleague Haussman has given an account, and the fire which took place in one of the finest manufactories at Sainte Marie aux-Mines, we have other instances of wool, stuff, and pieces of cloth which were not scoured taking fire in magazines when folded up, and even during the time of their conveyance from one place to another, when heaped upon each other. This is principally to be apprehended when linseed oil is employed in the manufacturing of cloth, or any other oil drying of itself, or rendered drying by oxide of lead.

In cloth manufactories, therefore, no oil but olive or rape oil ought to be employed for greasing wool.

It sometimes happens that in boiling flowers and herbs in oil, which is the case in several pharmaceutic operations, these herbs, after being taken out and dried, inflame spontaneously: care, therefore, must be taken, when they are thrown aside, not to heap them up near other combustible bodies.

We have several instances of ships having been burnt in port either by the spontaneous combustion of cordage heaped up and strongly covered with pitch, or of a mixture of boiling linseed oil and lamp black inclosed in a bag.

### 6. *The Boiling of Oily Matters.*

In the preparation of some kinds of varnish, such as printers' ink, where in general linseed oil boiled to a

certain consistence is employed, it often happens that the oil inflames, if the necessary precautions are not taken. The same effect is produced in melting butter, tallow, or any other greasy substance, if it be too much heated; so that in these operations every other combustible body should be kept at a distance, and a covering should be in readiness to place over the vessel as soon as the matter has caught fire: care also ought to be taken not to pour in water, which, instead of extinguishing the fire, would give more expansion to its activity.

### 7. *Torrefaction.*

There are many vegetable substances which by torrefaction acquire an increase of their property to inflame spontaneously if inclosed in bags of cloth, which leave them in contact with the surrounding atmosphere. Of this kind are sawdust, burnt coffee, the farina of gramineous and the fruits of leguminous plants, such as beans, lentils, pease, &c.

There are several instances of fires breaking out in stables by a bag of torrefied bran applied to the neck of a diseased animal, and which inflamed spontaneously. The people in the country persist in employing this remedy, for which others more efficacious and less dangerous might be substituted. At any rate, they ought to take care not to inclose the bran in cloth either too hot or too much torrefied.

Brewers, after causing the barley and other grain which they use for beer to germinate, dry it in a kiln or stove, except that destined for pale beer; and they generally dry it in a greater or less degree, to give to the beer a colour more or less dark. If the grain when taken from the kiln is put warm into sacks, it sometimes happens that they inflame, and occasion fires in brew-houses.

### 8. *Sulphurized and Phosphorized Hydrogen Gas.*

Subterranean fires and volcanoes are generally ascribed to the decomposition of pyrites and metallic sulphurets buried in the bosom of the earth. These pyritous masses are decomposed by the contact and concurrence of water and air, and the decomposition is always accompanied with a great expansion of caloric, and a disengagement of a highly inflammable gas called sulphurized hydrogen gas. This gas inflames at an elevated temperature, and may communicate inflammation to the sulphur of pyrites, to coals, and other bituminous matters with which they are in general accompanied.

Similar inflammations are observed sometimes in the neighbourhood of coal mines. In working coal mines, veins and insulated pieces of pyrites are often found: as pyrites always communicates a bad quality to coal, the miners generally lay it aside and take it out of the pit. If these heaps of pyrites, intermixed with coal, are then exposed to the alternate action of the sun and rain, they become heated, and inflame. Great care must therefore be taken that such heaps of pyrites be removed from all combustible bodies to which they would necessarily communicate inflammation. There are many operations in nature in which sulphurized hydrogen gas is produced; but it often forms other combinations, according as it is dissolved in water, or is disengaged at a temperature too low to be able to inflame.

When phosphorus is boiled in a solution of potash or of lime, there is disengaged phosphorized hydrogen gas, which being much more combustible than sulphurized hydrogen gas, inflames at a low temperature as soon as it comes into contact with atmospheric air. This gas, which in chemical experiments exhibits the beautiful spectacle of a fountain of fire over water, is produced naturally by

the putrefaction of animal substances which have been buried. The flames often seen to issue from the earth, and which are known under the name of will-with-the-wisp, arise only from phosphorized hydrogen gas: as these fires generally appear in the open fields in places where they are not in contact with dry combustible matters, they rarely produce disagreeable accidents; but it is disengaged also in forests, and it may happen in very warm summers, when the grass and bushes are entirely dry, that the gas in combustion will meet with these combustible matters, set fire to them, and in this manner burn the whole forest. We ought not therefore, on too slight grounds, or without sufficient reason, to ascribe to malevolence or to incendiaries those fatal events which sometimes are the result of causes purely natural.

### 9. *Sulphuret and Phosphuret of Lime and Potash formed during the Combustion of several Vegetables.*

When gypsum (sulphate of lime) or any other sulphate, either earthy or alkaline, is strongly heated with charcoal of wood, or in general with any combustible matter which by heat is reduced to charcoal, sulphur is formed. These salts produce sulphureous waters, if animal or vegetable substances are suffered to remain in water in which they are dissolved, so that very often nothing is necessary but a little sulphate of lime to communicate to stagnant water the odour and taste of sulphur.

Pyrophorus is obtained by calcining common alum or sulphate of potash with sugar, farina, or any matter which becomes reduced to charcoal.

The inflammation of pyrophorus, which takes fire merely by the contact of damp air, arises only from the sulphuret of potash, which by attracting the humidity of the air becomes heated to such a degree as to set fire to

the carbonaceous matter around it, and which being in a state of great tenuity is the more disposed to burn.

But as many of our common combustible matters contain sulphuric salts, it may happen that in their combustion there is sometimes accidentally formed some pyrophoric matter, which remains in the residuum of the combustion; especially if the combustible matter is not entirely consumed, and if a part of it only is reduced to charcoal; which sometimes happens in fire-places where the combustibles are not burnt in grates, and where the ashes are not separated from the charcoal. There have been instances of houses being set on fire by ashes intermixed with charcoal taken too soon from the hearth and deposited in places where they were surrounded by combustibles, which they set fire to by spontaneous inflammation. Happily these causes of fires rarely occur; for pyrophorus does not long retain its property of inflaming, and it is often decomposed soon after it has been formed, without being able to produce that disagreeable event. Care, however, ought always to be taken not to put ashes newly burnt, and which are still mixed with charcoal, in places where they may have a communication with combustibles.

The formation of a pyrophoric matter is remarked chiefly in the preparation of common soda, which is obtained by the incineration of several marine plants containing a great deal of sulphate of soda, and which in burning furnish always a greater or less quantity of sulphur according to the manner in which the operation is directed.

The formation of the phosphuret of lime has great analogy with that of the sulphuret of lime. Though the phosphoric acid is not found so often in vegetables as the sulphuric acid, it however exists in them in much larger quantity than has hitherto been supposed; it is found chiefly in the greater part of plants which grow in marshy

places, in turf, and in several kinds of white wood. By reducing these kinds of wood to charcoal there is sometimes formed a small quantity of phosphorus, which may remain combined with the same bases which retained the phosphoric acid before the combustion: phosphorus, by contracting other combinations, may be no longer susceptible of producing any accident; but it may happen also, by the concurrence of various circumstances, that charcoal impregnated with any phosphuret, when exposed to the action of warm and moist air, will disengage phosphorated hydrogen gas, which by the contact of the atmospheric air may kindle, and communicate inflammation to the mass of charcoal.

Two instances of this kind of spontaneous combustion took place in the powder manufactory of Essone in the years 8 and 10. The first time the fire broke out in the box for sifting the charcoal, and the second time the charcoal repository took fire, without room being left for suspecting that it could arise from any thing but spontaneous inflammation. The different reports on these two events were inserted in the public journals, but the explanations given were not sufficiently satisfactory. It appears very probable that they were occasioned by some phosphorus contained in the charcoal; and this explanation is the more founded in reason, as the alder wood used at Essone as well as in most of the powder manufactories, and which on many accounts deserves the preference over other kinds of wood for the making of gunpowder, contains phosphoric acid; at least that which grows in our neighbourhood does.

Charred turf begins to be used in some manufactories, and for different operations; but as it is much disposed to spontaneous inflammation, the use of it ought to be abandoned, or great care should be employed in preserving it. Magazines of this substance, both at Paris and

other places, which were uncovered, have been inflamed by the combined action of the heat and rain.

### 10. *The Phosphorus contained sometimes in Charcoal.*

It may happen also that the small quantity of phosphorus, which is sometimes formed in the carbonization of different kinds of wood, without uniting to lime or to potash, remains combined with the charcoal, which in this case does not disengage phosphorated hydrogen gas, and does not easily inflame by the mere action of water or moist air, but which may produce a violent detonation when struck with saltpetre (nitrate of potash.) It is very probable that the three successive explosions which took place in the powder-mill of Vonges were in part owing to a similar cause.

Charcoal in general has a great influence on the different products of nature and the arts. It is often observed in forges and founderies, especially those of iron, that the products vary according to the nature of the charcoal employed. The bad quality found sometimes in iron of being cold short is generally ascribed to phosphoric acid contained in the ore; but as the ore by the same processes furnishes in the same foundery one kind of iron better than another, the difference appears often to arise in part from the charcoal.

## No. 34.

### *Addition to a Memoir on the Method of giving to Cotton and Linen thread the Adrianople Red, and other fixed Colours, and on Spontaneous Inflammations. By* J. M. Haussman *.

To give to cotton and linen thread all kinds of durable colours, nothing is necessary but to fix on these

* Tilloch, v. 18, p. 340. From the *Annales de Chimie*, No. 144.

threads, in any manner whatever, more or less alumine, after having applied to them a slight stratum of oil. The complete success of the result, however, depends on certain modifications to be observed in the processes.

The numerous trials which I made in dyeing had so much familiarised me with experiments on a small scale, that I at last never failed. It was only after I published my memoir on maddering inserted in the *Annales de Chimie**, that I experienced any difficulties in the application of oil when operating on a larger scale. Linseed oil, which had always given me a milky mixture in limited proportions with alkaline solution, then speedily separated when I wished to make a larger provision, and under these circumstances the impregnation of the skains became impossible. The case was the same with all the fat oils: fish oil, however, will remain in mixture for a considerable time; but its odour is too disagreeable.

To remedy the inconvenience of the separation of oil in the alkaline solution of alumine, I had recourse to drying oils; that is to say, oil boiled with metallic oxides. Linseed oil boiled with minium, ceruse, or litharge, by means of water to prevent combustion, dissolves a considerable portion of the oxide of lead, and will keep mixed with the alkaline solution of alumine, under the milky form, the whole time necessary for the impregnation of the skains. By employing this mixture in proper proportions, and in the manner I have indicated in my memoir, following strictly in other respects the process such as I have described it, one cannot fail to obtain beautiful and lasting colours. However, notwithstanding the simplicity of this process, I cannot recommend the use of it, because it exposed me to the danger of a conflagration in the following manner:

* See Emporium, preceding numbers.

With a view to discover whether red cotton, which had not the requisite fixity, could acquire it by impregnating it with an alkaline solution of alumine, with excess of boiled linseed oil, and drying it, and then boiling it a very long time in bran water, I mixed the alkaline solution of alumine in the proportions of an eighth, a twelfth, and a sixteenth part of boiled linseed oil. I then immersed in this mixture some dozens of skains of dyed cotton, which, after being dried in the open air for a whole day the preceding summer, were placed under the window of my cabinet, on a straw-bottomed chair. Being that day indisposed, I went to bed at seven in the evening, without any uneasiness in regard to my cotton. My children, about an hour after, went into my cabinet to look for some sheets of paper, and observed in the cotton neither heat nor any smell of combustion. All the workmen of the manufactory were in a state of profound sleep, when one of the watchmen of the bleachfield, seeing my cabinet all illuminated, called out "Fire!" and awaked us between twelve and one o'clock in the morning. My sons, knowing that I was not able to get out of bed, and unwilling to lose time in searching for the key, burst open the door of the cabinet, which is an uninhabited and detached building. They entered, notwithstanding the thick smoke and insupportable odour of the oily combustion, and found the cotton and chair so much on fire, that the flame, which rose to the ceiling, had already broken the glass and burnt the frame of the window. They immediately concluded, that this fire could arise only from the spontaneous inflammation of the cotton impregnated and covered with boiled oil, since no person had entered the cabinet either with a lighted pipe, or with any other matters in a state of combustion. Observing that several persons in the manufactory refused to assent to this explanation, I again impregnated some dozens of skains of old

cotton, which had been badly dyed, in the same manner as the burnt cotton. I then dried them in the open air; and seeing that the weather threatened rain, I exposed them on a rope, extended above the court, desiring one of the night watchmen to look at the cotten every quarter of an hour, and to throw it into a bucket of water as soon as he should see it begin to become heated. But as the man could not conceive the possibility of the spontaneous inflammation of cotton, as he himself acknowledged, he went his rounds without so much as looking towards the court. At length, however, he came back to rest himself, and, by the great light he perceived, was convinced of what I had foretold would be the consequence of neglect. Finding that the cotton and rope were both burnt, he took the bucket of water to extinguish the supporters, which were already both on fire.

About fifteen years ago, with a view of preventing similar dangers, I made experiments at Colmar on spontaneous inflammations. I mentioned the probability of fires being occasioned by warm bodies,* or bodies tending to be heated, when deposited inconsiderately in places to which fire may be communicated. The bodies of this kind, which I mentioned to those present, who were not sufficiently acquainted with the phænomena of spontaneous inflammations, are roasted coffee, cacao, fermenting plants, ointments made with metallic oxides, inclosed quite hot in wooden barrels, bales of raw cotton, as well as linen or flax heaped on each other at a warm temperature, and even linen which has been ironed and put warm into drawers; in a word, all bodies covered with oil, such as silk and skains of cotton. I showed them besides, that in all cases where the oxygen of the atmosphere is rapidly attracted and absorbed by any cause whatever, the caloric, which served as a base to the oxygen and gave it the qualities of gas, or elastic proper-

ties, is disengaged in such abundance, that if the absorbing bodies are susceptible of taking fire, or if combustible bodies are in the neighbourhood, a spontaneous inflammation will take place.

To prove to the persons present, to whom chemical experiments were not familiar, the theory of these inflammations, I made the following experiments:—1st, The incandescence of a mixture of iron filings and sulphur kneaded in water.—2d, The inflammation of boiled linseed oil by means of highly-concentrated nitric acid. —3d, The inflammation of phosphorus in atmospheric air, as well as in pure oxygen gas, placed for that purpose in a porcelain capsule over boiling water, in order to separate the moleculæ by fusion without having recourse to friction.—4th, The inflammation of phosphorated hydrogen gas by the contact of the atmosphere—an imitation of will-with-the-wisp.—5th, The combustion of pyrophorus thrown into the atmosphere, and in pure oxygen gas.—6th, The reduction into a charry igneous mass, produced by the action of the atmospheric air of torrefied bran put quite hot into a bag, the texture of which was not too close.

I was well aware, that essential or volatile oils become resinous, and that drying oils boiled with metallic oxides become thick and hard in consequence of their combination with oxygen. It was also for this reason that my skains, covered with a mixture of boiled linseed oil, were exposed during the whole day to the air, extended and insulated on poles; but I then supposed them to be saturated with oxygen, and consequently incapable of producing the least accident. I was so secure in this point that I caused a great deal of impregnated cotton to be dried at several times in warm apartments; they were not deranged but at the moment when they were washed in order to be dyed. It may however be possible that the

proportion of a thirty-sixth part of boiled linseed oil, mixed with an alkaline solution of alumine, may be insufficient to excite spontaneous inflammation in skains of cotton heaped up after they have been dried. Those, therefore, who are induced, on account of the simplicity of the process, to employ a mixture of boiled linseed oil with an alkaline solution of alumine, must take the precaution to leave the skains extended and insulated on poles, until they are to be washed, previous to the operation of dyeing, which, together with the brightening, completely removes the excess of oil, and leaves only the portion saturated with oxygen; so that no fears need afterwards be entertained.

Since the publication of my memoir, I have convinced myself that the simplest brightening of Adrianople red, by which the liveliest and most durable shades are obtained, consists merely in very long ebullition in bran water in a boiler furnished with a cover, having in the middle a pipe to suffer the vapours to escape, and prevent the bursting of the vessel; care only must be taken to renew the water as often as it becomes red; that is to say, two or three times at the commencement of the ebullition. Without this precaution the skains would continually resume the fawn-coloured parts which the bran water removes, and would never acquire a bright colour.

One may avoid all danger without lessening much the simplicity of my process, whether the skains be heaped up or not: nothing is necessary but to apply at two different times a stratum of olive oil, very much divided, after they have been well lixiviated, washed, and dried. For this purpose, a ley is formed of carbonate of potash or soda, which indicates one degree, or a degree and a half, of the areometer for saltpetre. Some drops of olive oil are then dropped into it, to try whether the result will be a milky mixture, or whether the oil will ascend in its

natural state to float over the ley; for, as the alkaline carbonate may contain more or less heterogeneous parts, in that case the ley must be weakened or strengthened by a new portion of alkali, until it absolutely assume a milky appearance by the mixture of oil. When the ley is properly proportioned, thirty-two parts of it must be mixed at first gradually and then more rapidly, continually stirring it, with one part of olive oil. This milky mixture will keep a long time; and if it be observed that the oil attempts to float under the form of cream, the mixture must be again stirred. The impregnation of the skains should be intrusted to workmen most experienced in this operation, because an exact distribution of the oily parts has a great influence in regard to the equality of the shades. Each workman ought to put as much of the milky mixture into any vessel as will admit of a certain number of skains to be squeezed and twisted in it with facility. This labour must be continued, always taking the same number of skains and the same quantity of milky mixture. The part which has been expressed, each time, must be poured into a vessel apart; and the quantity of oil which the skains appear to have absorbed must be restored, if the little value of this residuum, in consequence of its containing but a small quantity of oil, does not make it be rejected. The impregnation may be effected in the whole mass of the milky mixture; but in this case it will be necessary to continue to replace the quantity of oil which the skains may have absorbed, as soon as a diminution is observed in the intensity of the milky appearance. Expertness in this process may be easily acquired by practice. After the whole skains have been dried together, they must be impregnated a second time as before without being previously washed; and when they have been dried they may be impregnated, as I have mentioned in my memoir, either once, two or three times, in the

alkaline solution of alumine, pure and without any mixture: by immersing the skains, shades more or less dark will then be obtained according to the number of impregnations.

To obtain, however, bright and at the same time uniform shades, it will be better to employ three impregnations, properly weakening the alkaline solution. One may then impregnate three times successively in this concentrated or weakened solution without previous washing: by these means the manipulations, which are often tedious and troublesome, may be shortened; but in this case it will be necessary to examine the solution from time to time, to see whether what the impregnated and dried skains discharge in it do not render it too strong.

In re-dyeing shades of red, it will be necessary to ascertain first whether they have been brightened by means of boiling bran water, or by soap and alkalies. In the first case they will become darker, by still attracting colouring particles of the madder; in the second they are weakened, and lose the excess of alumine, without which repeated dyeing can produce no effect. The removal of this excess of alumine may be prevented by substituting for soap and alkalies, to produce crimson shades, a portion of the alkaline solution of alumine, which must be added to the bran water towards the end of the brightening. Real Adrianople reds become much darker by re-dyeing them, and turn brown by the test of ebullition in water alkalized by ashes: these reds change only very little before they are re-dyed. In general, reds become brown more or less disadvantageously according to the time they have been boiled in brightening them. As the real Adrianople reds have a strong smell, it is probable that the Turks employ fish oil, which they add directly to the alkaline solution of alumine, or mix with a very weak ley of alkaline carbonate.

The processes for dyeing Adrianople red can be infinitely varied; for in whatever manner and by whatever solvents, whether acids or alkalies, the alumine may have been fixed on the skains, when a light stratum of oil has been applied, reds more or less bright will be obtained, according to the precaution employed in maddering and brightening.

It appears to me more difficult to explain the reason why oils combine so easily with caustic alkalies to form soaps, and do not admit of being mixed with concentrated leys of alkaline carbonates, while they form a kind of artificial milk with these leys when very much diluted, because one might suspect a tendency to combination in such milky mixtures. A mere suspension of the integrant oily moleculæ, which would take place rather in the diluted ley than in the same ley more concentrated, is equally difficult to be explained.

It remains that I should rectify an injury done to the process for dyeing real Adrianople red in other manufactories. What was shown to me was only of the most inferior quality. I have seen some since equal to the finest and most durable that can be produced. So that I am inclined to think that the merchandize of the Turks, like that of all other nations, is suited to the price which the purchaser wishes to give.

I must observe also, that among my burnt cotton there was some both times which had been impregnated with a weak ley of carbonate of soda and boiled linseed oil in the proportion of an eighth, a twelfth, and a sixteenth. It therefore remains to ascertain whether this cotton will sooner catch fire than that impregnated with a mixture of the alkaline solution of alumine and boiled linseed oil in the same proportions. As the latter mixture is susceptible of attracting a little of the moisture of the air, I am inclined to think that cotton treated with the first will inflame

sooner. The trials which I continue to make in regard to the use of gall nuts in dyeing Adrianople red, induce me to believe that it is by the formation of a gallate of alumine that alumine is fixed upon cotton, that the gallic acid may be afterwards separated by an alkaline carbonate before the process of dyeing is begun. When I have acquired certain information on this subject, I shall not fail to publish the result.

## No. 35.

### *Agenda, or a Collection of Observations and Researches, the Results of which may serve as the foundation for a Theory of the Earth. By* M. de Saussure.

(Continued from page 208.)

#### CHAPTER XV.

#### *Observations to be made on primitive mountains.*

1. WHETHER there be any exception to the generally received opinion, that, in primitive mountains, no vestiges are discovered of organised bodies.

2. Whether it be true that in these mountains no indications are found of bitumen or marine salt.

3. To endeavour to determine the respective ages of the different kinds of primitive mountains; both compound, such as granite, porphyry, gneiss; and simple, as slate, serpentine, and primitive calcareous.

4. Whether, in particular, it be certain that granite is the most ancient stone of all those which form the outer crust of our globe, so that it is never found placed above (*superpose*) any other kind of stone.

5. Whether the large mountains composed of granite in one mass, even the best characterised, do not give certain indications of stratification or divisions by strata, though less regular than those of schistous mountains.

6. Whether in the bases of granite mountains the manifestation of strata be not hurt by the number of fissures, or spontaneous and irregular divisions.

7. Whether, even in the separate blocks of granite, an attentive eye does not discover some veins of mica, which affect the same direction, and such veins as induce the workmen, who wish to make mill-stones or other works more extensive in one direction than another, to prefer attacking the stone in a determined direction.

8. Whether the indications of the stratification are not observed in the interior part of granite mountains, as well as near their surface.

9. Whether among the granites in a mass, and those decidedly veined, there are not found such intermediary shades that it is difficult to mark the line of separation.

10. To determine the distinguishing characters of granites of modern formation.

11. To ascertain the truth of the assertion of the Pliny of France, that in proportion as people dig into a mountain, the summit and sides of which consist of granite, the granites, instead of being found more solid and more beautiful the farther they advance, change, on the contrary, below a certain depth, lose themselves, and at last vanish by gradually assuming the coarse (*brute*) nature of the live quartzy rock *.

12. Whether it be true that each primitive mountain is generally composed of one single stone, and of the same nature.

Mineraux, p. 105.

13. To examine whether there be found on the primitive mountains, at great heights, the scattered wrecks of secondary mountains. For my part, I never found any.

14. Whether primitive calcareous stone be found always with a granulated fracture, or the form of a saline marble, and never under a compact form.

15. Ought the porphyric schist of Werner, or the *porphyre schisteux a pate* of primitive petro-silex, to be considered as primitive or secondary? The same question in regard to the *mandelstein* or amygdaloid.

16. Is it fully ascertained, as I thought I observed in the Alps, and M. de Fichtel in the Carpathian mountains, that there exists pudding-stone or free-stone, if not primitive, at least of a formation anterior to that of all the other secondary stones?

17. Were the granites in a mass first deposited, because they were less soluble? and did they crystallise after the quantity or dissolving force of the waters began to diminish? and was it for a contrary reason that the gneiss, mica and magnesian stones crystallised later?

## CHAP. XVI.

### *Observations to be made on Transitions.*

1. To observe the intermediary genera and species of fossils, between one genus or one species of fossil, and the genera and species which have the greatest resemblance to them.

2. To observe, above all, the transitions through which nature has passed, when, having produced one genus or one order of mountains, she began to produce a different genus or order; for there is no change of order which has not been the effect of a revolution; and it is in the transitions that traces of these revolutions are to be found.

3. Thus we often see strata of free-stone or pudding-stone interposed between the primitive and secondary mountains; *breches* are seen to form the most elevated stratum, and consequently the newest of some calcareous mountains. We must study then the nature, dimensions and position of these remarkable strata.

4. Having found these transitions, or any others, in some mountains, if they are not then found in other mountains, you must examine whether their absence does not arise from their having been destroyed; vestiges of them are to be sought for; and if it appears that they never existed, you must endeavour to discover, in the nature and position of the mountains, what may have been the cause of their absence *.

## CHAP. XVII.

### *Observations to be made on the Remains and Vestiges of organized Bodies found in the Earth, in Mountains, and at their Surface.*

1. Their nature, bulk, and quantity; the extent, depth, and other dimensions of the strata where they are found†.

2. Their preservation. Whether entire or broken, decomposed or not; shells with their pearly covering (*nacre*); their colour; remains or traces of their fish, or their skin if there be any. To deduce, if possible, from these data, some idea of the time that has elapsed since these organised beings were deposited in the bosom or at the surface of the earth.

* The best method of observing mountains, in order to acquire a thorough knowledge of them, is, not to confine oneself merely to follow the valleys, but to intersect also, as much as possible, the principal chains and the branches detached from them in the direction of their breadth. Til.

† 1. A. If formed of trees, to mark down the direction of the strata; and whether they are placed horizontally, or inclined either towards the summit or the roots. Til.

3. The nature of the objects by which they are accompanied; such as sand, gravel, flints: whether angular or round; whether there are found in their neighbourhood other vestiges of organised bodies *.

4. Their nature. Whether they are lying in their natural position, or reversed, and turned upside down, so as to afford reason to conclude that they died on the spots which they now occupy; or whether they have been transported thither by some violent and irregular movement: whether, for example, the shells have the same attitude as in the bosom of the sea, the univalves on their mouth, and the bivalves on the valve that is least convex.

5. Whether they are in families, as in stagnant waters; or, on the contrary, thrown together in an irregular manner.

6. Whether all these circumstances are the same throughout the whole extent of the same bank; in the contiguous banks of the same lands, and the same mountains, and in those of the neighbourhood.

7. To ascertain whether fossil shells are found in the most ancient mountains, and not in those of a more recent formation; and thus to class, if possible, the relative ages and epochs of the apparition of the different species.

8. To compare exactly the bones, shells, and fossil plants with the living plants analogous to them; and thus to ascertain the truth of the assertion of Michaelis, that the fossil bones of quadrupeds (such as the elephant, rhinoceros, oxen, and stags,) have not an exact resemblance to those which are found at present alive.

9. If they are really different, to determine whether these differences are not varieties, or whether they characterise species.

* To pay particular attention to those of such organised bodies as may be found in the real veins. Til.

10. Whether, on the other hand, their identity is confirmed with those of analogous living ones; viz. to ascertain whether these analogous living ones are found at present, or have been found within the memory of man, in those countries which contain remains of them; and if the answer is negative, to discover the situation and distance of the nearest country where they are found.

11. If no analogous ones exist alive at present but in climates where the temperature is very different, to ascertain whether there are any indications of their having formerly existed, and of their having been conveyed to those countries where remains of them are still found; or whether, on the contrary, these remains seem to have been transported thither by currents, tides, or any other great movement of the waters.

12. In the like manner, whether there are found in the cold countries vestiges of the productions of warm countries; or reciprocally, whether in warm countries there are found vestiges of the productions of cold countries.

13. Whether fossil wood, or other vestiges of organised bodies, are situated in such a manner as to indicate that there were in the ancient ocean islands abounding with animals and vegetables.

14. To study with care the immense accumulations of bones deposited in heaps (*nids*), or strata, in the isles of Cherso, Osero, and elsewhere.

15. To examine the nature of the caverns which contain them; such as *Baumannshæle*, and others *.

16. Whether it appears that these caverns were the voluntary retreats of those animals who died there a natural death, or whether their bodies were conveyed thither by the waters †.

* In the Harz, and those of Gailenreuth in Franconia. Til.

† Or, whether these bones are found, not only in caverns, but also in the strata from which the caverns have been formed. Til.

## No. 35.

## *Description of a Portable Bridge, invented by Mr.* James Elmes, *Architect, of College-Hill, Queen-Street, Cheapside, London* *.

(With a Plate.)

BRIDGES upon this construction may be rendered either permanent or otherwise. The only difference will be, that for the former the parts may be strongly bolted and fastened together, instead of being joined by contrivances which admit of the parts being separated, for the convenience of removal, as in the drawing now sent. (See plate 7.)

The component parts shall be first described, and afterwards the manner of applying them. A is a strong iron frame that forms the bottom. B is a square frame of the same metal, fastened by hinges, to the ends of A, for the purpose of falling down flat upon the bottom for conveniency of packing, as shown by the figure C. A skirting of iron plate marked D, is also strongly fixed to the bottom, as in the elevation of the whole P, and in the figure B. Two spring catches are attached to this skirting to keep the sides steady when erected. One of these catches E on a larger scale is shown in the drawing. The remaining detached parts are marked F and G. F is a square iron link separated in the middle, and each part opening by a spring. G is a kind of staple opening and closing by a double worm described round its superficies working in an interior screw, contained in a box, opening and closing very considerably by a single revolution of the box round the screw, by the means of a small handspike H.

As many of each of the above described parts as are necessary, according to the width of the river or valley

* Tilloch, vol. 33, p. 10. Communicated by the inventor.

Mr. Elmes' Portable Bridge.

intended to be passed, with a sufficient quantity of planking posts, chains, &c., according to the existing circumstances of the case, are the whole of its component parts.

A bridge on this principle for a river, &c., of a considerable width is very portable; for several of the square frames may be packed upon each other in carriages or waggons of the dimensions of eight feet three inches long, three feet four inches wide, and as many feet high as it may be wished to pack a number of frames; two of them rising one foot. The links and staples can be packed in cases, each sort separate.

The method to be used in passing a river with this bridge shall now be described. (A valley is passed in the same manner; but there being no water to pass, the bridge will be easier supported from the under side.) First, two sufficient holes are to be dug on one side the river, at the distance apart of the width of the bridge, which in this plan is nine feet, and the posts I, are first to be prepared with prongs, &c., as in the dotted figure K: next the four smaller ones L, properly secured and well rammed. Then taking any one of the pieces C. fix it on the posts I and L as drawn, and support it on two well driven piles, if the shore will permit: and hooking on the next piece with one of the links F through the eyes at the bottom of the piece, and one of the staples G, fixed into the holes of the upright piece or parapet, it will there hang. Several more are to be hanged on the same way, leaving under them, where necessary, barges or other craft, moored with supporters under them *pro tempore*. When completed to the opposite shore, the same process of fixing the posts. &c., is to be repeated, and when fastened to these posts, the under supports may be taken away, and the whole left suspending by itself. Nothing now remains but for the superintendent of the work to screw the staples, by the handspike H, till the bridge ri-

ses by a small curvature by opening the interstices N at the top. It is not required to rise more than a small degree above level, only just enough to stiffen the whole, and cause it to lie like a stiff plank, and rather to occasion a thrust outwards than otherwise, which when the weight has brought down may be again raised by the same operation. The planks are now to be laid on to meet at the intervals as in the ichnographic plan O, of which P is the elevation complete. Q is a perspective view of three joints looking along the bridge with the planks, &c., drawn faintly.

## No. 36.

### *A Treatise on the Cultivation of the Vine, and the Method of making Wines. By* C. Chaptal.

(Continued from page 193.)

#### III. *Of the Means requisite to dispose the Wine for Fermentation.*

AS ripe grapes rot on the twigs, the faculty which the sweet and saccharine juice of the fruit possesses of being converted into a spiritous liquor may be considered as the pure effect of art, and it is by the fermentation of this juice expressed that this change is produced. The method of disposing grapes to fermentation varies in different countries; but as the differences occasioned in so essential an operation rest on certain principles, I have thought it proper to make them known.

We are informed by Pliny (*De brio vino apud Græcos clarissimo*), that the grapes were collected a little before their maturity; that they were dried by being exposed to

the ardent sun for three days, turning them three times every day, and that on the fourth they were expressed.

In Spain, particularly in the environs of St. Lucar, the grapes are left exposed for two days to the full ardour of the sun.

In Lorraine, part of Italy, Calabria, and the island of Cyprus, the grapes are dried before they are expressed. It is in particular when white sweet wines are to be made that the grapes are dried, to thicken the juice, and thereby to moderate the fermentation.

It appears that the ancients were acquainted not only with the art of drying the grapes in the sun, but even that they were not ignorant of the process employed to boil and concentrate the must; on which account they distinguished wines into three kinds, *passum, defrutum,* and *sapa.* The first was made from grapes dried in the sun; the second was obtained by reducing the must one-half by the means of heat; and the third, from must so concentrated that there remained no more of it than a third or a fourth. For very interesting details respecting these operations the reader may consult Pliny and Dioscorides. These methods are still used at present, and we shall show, when we come to speak of fermentation, that it may be directed and managed in an advantageous manner by inspissating a portion of must, and afterwards mixing it with the remainder of the mass; we shall show also that this is an infallible method for giving to all wines a degree of strength to which the greater part of them cannot otherwise attain.

Agriculturists were long divided in regard to the question, whether it is most advantageous to free the grapes from the stalks or not? Each of these methods has its partisans, and writers of merit may be quoted who have supported both. In my opinion, in this as well as in other cases, both parties have been too exclusive, and by bring-

ing back the question to its real point of view it will be easy for us to terminate the difference.

It is certain that the stalks are harsh and austere, and it cannot be denied, that wines produced from grapes not freed from the stalks do participate in that quality: but these are weak and almost insipid wines, such as the greater part of those made in moist countries, where the slightly harsh taste of the stalks heightens the natural insipidity of that beverage. Thus, in the Orléanois, agriculturists, after freeing the grapes from the stalks, have been obliged to abandon this method, because they observed that the grapes freed from the stalks furnished wines more inclined to become oily. It results also, from the experiments of Gentel, that fermentation proceeds with more force and regularity in must mixed with the stalks than in that which has been freed from them; so that in this point of view the stalks may be considered as an advantageous ferment in all cases where it is to be apprehended that the fermentation may be too slow or retarded.

In the environs of Bourdeaux the red grapes are carefully freed from the stalks when it is proposed to obtain good wine. But this operation is still modified according to the degree of the maturity of the grapes. It is much employed when the grapes have little ripeness, or when frost has taken place before their being collected; but when the grapes are very ripe, it is performed with less care. Labadie observes, in the information with which he has supplied me, that the stalks must be left to facilitate the fermentation.

White grapes are never freed from the stalks; and experience proves, that grapes separated from the stalks give wines less spiritous, and more susceptible of becoming oily.

The stalks, no doubt, add neither to the saccharine principle nor to the aroma; and in this double point of view, they cannot contribute by their principles either to the spiritous quality of the wine or to its flavour, but their slight austerity may correct, with advantage, the weakness of some wines; and besides, by facilitating the fermentation, they concur to effect a more complete decomposition of the must, and to produce all the alcohol it is susceptible of yielding.

Without wandering from the subject in question, we may consider wines also under two points of view, according to the uses to which they are applied. They are all employed either as a beverage or for distillation. In the former, qualities are required which would be useless in the second. Taste, which forms almost the whole merit of the one, adds nothing to the qualities of the other. Thus, when wine is destined to be distilled, it is necessary to pay attention only to the means of developing a great deal of alcohol: it is of little importance whether the liquor be tart or not; in this case, to free the grapes from the stalks would be lost labour. But if wine is prepared for a beverage, it is then necessary to give it an agreeable taste and a delicate flavour, and for this purpose, care must be taken to avoid every thing that may alter these valuable qualities. On this account, therefore, it is necessary to withdraw the stalks from the fermentation, to pick the grapes, and to clean them with care.

It is, probably, in consequence of a knowledge of these effects, which experience every day places before the eyes of the agriculturist, rather than from caprice or habit, that in certain countries the grapes are freed from the stalks, and that this process is omitted in others. To attempt to reduce the whole to one general method would be showing ignorance of the effects produced by the stalks in fermentation, and of the difference which exists in the

various qualities of the grapes. In the south, where the wine is naturally generous, the stalks would only add a disagreeable harshness to a liquor already too strong by its nature. All the grapes, therefore, destined to form wines for the table, are freed from the stalks, while those destined for distillation are fermented with them. But what may appear astonishing is, that in different parts of the same canton in France, we see some agriculturists free their grapes from the stalks, and extol their method, while others in the neighbourhood, equally skilful, reject this practice, and endeavour to support their method by the result of their experience. The one makes wines more delicate, the other wines of a stronger quality; both find partisans of the liquor which they prepare: but this is a matter of taste, which does not contradict the principles we have here laid down.

In general, a fork with three prongs, which the workman turns and agitates in a circular manner in the vat where the grapes are contained, is employed for freeing them from the stalks. By this rapid motion the stalks are detached from the grapes, and, being drawn up to the surface, are removed with the hand.

They may be freed from the stalks also by means of a common sieve formed of osier twigs, distant from each other about half an inch, and having above it a close osier pad or presser, about four inches thick.

But whether the grapes be freed from the stalks or not, it is indispensably necessary to tread them, in order to facilitate the fermentation, and this process is performed as the grapes are collected and brought home from the vineyards. The operation is nearly the same in all the wine countries, and is performed, for the most part, in a square box, open at the top, and about a yard and a half in breadth. The sides consist of wooden bars, with intervals of such a size that the grapes may not pass through

them. This box is placed on the vat, and kept in its position by two beams resting on the edge of the vessel. The grapes are poured into this box as they arrive from the vineyards, and are immediately trod, in a strong and equal manner, by a man, having on his feet large wooden clogs, or strong shoes. While employed in this labour, he rests with his two hands on the edge of the box, stamping with rapidity on the stratum of the grapes, while the expressed juice runs into the vat through the interstices left between the bars. Nothing remains in the box but the pellicle and stalks of the grapes; and when the workman finds that all the juice is expressed, he raises a plank, which forms a part of one of the sides of the box, and pushes the skins and stalks with his foot into the vat. This door slides in two grooves, formed on two perpendicular bars. As soon as the box has been cleaned, a new quantity of grapes are introduced to be trod in the same manner; and this operation is continued till the vat is full, or until the vintage is terminated.

In some countries the grapes are trod in tubs. This method is perhaps better in regard to the effect than the former, but it is slower, and cannot be employed in countries where the vineyards are of great extent.

There are some countries also where the grapes are poured into the vat as they come from the vineyards; and when fermentation begins to take place, the must, which floats on the surface, is carefully removed in order to be conveyed to the casks, where the fermentation is completed. The residuum is then squeezed under a press, to form wine of a higher colour and less flavour.

In general, whatever be the method employed in treading the grapes, what concerns this important operation may be reduced to the two following principles:

Grapes cannot experience spirituous fermentation unless the sugar be extracted by proper pressure, in order

that it may be subjected to the action of those causes which determine the movement of fermentation.

It follows from this fundamental truth, that not only the means proper for treading the grapes ought to be employed, but that the operation will not be complete unless all the grapes are equally pressed; without this the fermentation can never proceed in an uniform manner: the period of the decomposition of the expressed juice would terminate even before the grapes which escaped being trod upon had begun theirs, and there would thus be produced a whole, the elements of which would no longer bear relation to each other. However, on examining the product deposited in the vat after the treading is finished, it will readily appear that the compression has been always unequal and imperfect; and by reflecting a moment on the rude processes employed for treading the grapes, there will be no reason for being astonished at their imperfection of the results.

It appears, then, that to give to this very important part of the labour of the vintage the necessary degree of perfection, it would be necessary to submit to the action of the press all the grapes as they are brought from the vineyard. The juice would be received in a vat, where it might be left to spontaneous fermentation. By this method alone the movement of decomposition would be exercised on the whole mass in an equal manner; the fermentation would be uniform and simultaneous in regard to all the parts; and the signs which announce, accompany, or follow it, would not be disturbed or obscured by particular movements. The must, freed from the stalks and husks, would no doubt produce wine less coloured, more delicate, and more difficult to be preserved; but if the inconveniences of this method exceeded the advantages, it would be easy to prevent them by mixing the expressed refuse with the must.

In consequence of these principles, care ought to be taken to fill the vat in twenty-four hours. In Burgundy the vintage is terminated in four or five days. Too long time would be attended with the disagreeable inconvenience of a successive series of fermentations, which, on that account alone, would be all imperfect; a portion of the mass would be already fermented, while the fermentation would be scarcely begun in another. The wine thence resulting would then be a real mixture of several wines more or less fermented. The intelligent agriculturist, therefore, anxious for the quality of his products, ought to determine the number of the vintagers according to the known capacity of his vat; and when unexpected rain makes him suspend the labour of collecting the grapes, he ought to leave to ferment separately the juice of those already collected and placed in the vat, rather than run the hazard of exposing himself some days after to the danger of interrupting its movements and altering its nature by the addition of fresh and aqueous must.

*(To be continued.)*

## No. 37.

## *On the Penetration of Balls into uniform resisting Substances. By* W. Moore, *Esq.**

*To Mr. Tilloch.*

Sir,

SHOULD the following paper on the destruction of an enemy's vessel at sea by artillery be thought deserving a place in your excellent Magazine, you are at liberty to make use of it accordingly.

I am, sir,

Your most obedient servant,

W. Moore.

Royal Military Academy,
Woolwich, November 10, 1810.

* Tilloch. v. 36, p. 325

### Lemma I.

*If two spheres of different diameters and different specific gravities impinge perpendicularly on two uniform resisting fixed obstacles, and penetrate into them; the forces which* retard *the progress of the spheres will be as the absolute resisting forces or strengths of the fibres of the substances directly, and the diameters and specific gravities of the spheres inversely.*

Let R and $r$ denote the absolute resisting forces of the two substances; F and $f$ the retardive forces; D, $d$ the diameters of the spheres; Q, $q$ their quantities of matter, and N, $n$ their respective specific quantities. Then the whole resistances to the spheres, being by mechanics proportional to the quantities of motion destroyed in a given time, will be as the absolute resisting forces of the substances and quantities of resisting surfaces jointly; or as the resisting forces of the substances and squares of the diameters of the impinging spheres: that is, $\frac{M}{m} = \frac{R}{r} \times \frac{D^2}{d^2}$.

But in general $\frac{M}{m} = \frac{F}{f} \times \frac{Q}{q}$: therefore equating these two values of the whole resisting forces, we obtain $\frac{F}{f} \times \frac{Q}{q} = \frac{R}{r} \times \frac{D^2}{d^2}$, and $\frac{F}{f} = \frac{R}{r} \times \frac{D^2}{d^2} \times \frac{q}{Q}$: and since $\frac{q}{Q} = \frac{d^3}{D^3} \times \frac{n}{N}$, it is $\frac{F}{f} = \frac{R}{r} \times \frac{D^2}{d^2} \times \frac{d^3}{D^3} \times \frac{n}{N} = \frac{R}{r} \times \frac{d}{D} \times \frac{n}{N}$: that is, the forces retarding spheres penetrating uniform resisting substances are as the absolute strengths of the fibres of the substances directly, and the diameters and specific gravities of the spheres inversely.

### Lemma II.

*The whole spaces or depths to which spheres impinging on different resisting substances penetrate; are as the squares of the initial velocities, the diameters and specific gravities of the spheres directly, and the absolute strengths of the resisting substances inversely; or,* $\frac{S}{s} = \frac{V^2}{v^2} \times \frac{D}{d} \times \frac{N}{n} \times \frac{r}{R}$.

For by mechanics we have $\frac{S}{s} = \frac{V^2}{v^2} \times \frac{f}{F}$; and by the preceding lemma $\frac{f}{F} = \frac{r}{R} \times \frac{D}{d} \times \frac{N}{n}$, which substituted in the above it becomes $\frac{S}{s} = \frac{V^2}{v^2} \times \frac{D}{d} \times \frac{N}{n} \times \frac{r}{R}$.

These being premised, I now proceed to resolve the following most important

### Problem:

*To find a general formula which shall express the quantity of charge for any given piece of ordnance to produce the greatest destruction possible to an enemy's ship at sea; it being supposed of oak substance of given thickness, and at a distance not affecting the initial velocity of the shot.*

By Lemma 2, we have, generally, $\frac{V^2}{v^2} = \frac{S}{s} \times \frac{d}{D} \times \frac{n}{N} \times \frac{R}{r}$. Also the charges of powder vary as the squares of the velocity and weight of ball jointly. * Hence, since it has

* This law of variation of the charges does not exactly obtain in practice after a certain charge, on account of the definite lengths of the guns; but it is presumed the deviation from it, if known, would not materially affect our results.

been determined from experiment that a charge of half a pound impelled a shot weighing one pound with a velocity of 1600 feet per second: we shall, considering V the velocity of any ball impinging on the side of the vessel, have for the expression of the charge impelling it through the space $S = \frac{S\,d\,n\,R\,v^2 w}{2\,D\,s\,N\,r \times \overline{1600}|^2}$.

Now to apply this in the present instance, it is first necessary that a case be known concerning the penetration of a given shot into oak. Such a case is presented at page 273 of Dr. Hutton's Robins's New Principles of Gunnery. It is there asserted that an 18-pounder cast-iron ball penetrated a block of well-seasoned oak, such as ships of war are generally built with, to the depth of $3\frac{1}{2}$ inches when fired with a velocity of 400 feet per second. Making, therefore, this the standard of comparison for all cases where the object is of oak substance, we shall have for the charge *generally* $\frac{400^2 \times \cdot 42}{2 \times 1600^2 \times \frac{7}{24}} \times \frac{S\,n\,R\,w}{D\,N\,r}$; or, because the balls are of the same specific gravity, and the substance the same, or $R = r$, and $N = n$; it will be $\frac{400^2 \times \cdot 42}{2 \times 1600^2 \times \frac{7}{24}} \times \frac{S\,w}{D} = \cdot 045 \times \frac{S\,w}{D}$; that is the charge varies as the space to be penetrated and weight of ball directly, and diameter of the ball inversely.

But the charge by the question being to produce the greatest effect possible in the destruction of the vessel; S in the above formula must always be put equal to the given thickness of its side *plus the radius of the ball*; since it is well ascertained that, for a shot to produce the most damage to any splintering object, such as oak; it must lose all its motion just as it quits the superior or further surface of it. Hence the charge in question is

$= .045 \times \frac{(\acute{S}+\frac{1}{2}D)\,w}{D}$. $\acute{S}$ being the thickness of the side of the vessel, $w$ the weight of the ball, and D its diameter.

We have supposed, that the resistance opposed to the ball's motion is uniform throughout the entire penetration; which is not strictly true; since that resistance depends partly on the quantity of the surface resisted, which continually varies until the ball has penetrated to the depth of its radius; when it continues uniform till it arrives at the further surface of the object; where the resistance again commences its variation. These deviations from uniformity are about sufficient to set against that of the law of variation of the charges before mentioned; the velocities from them falling somewhat short of the law there prescribed after a certain charge.

### Example I.

*An enemy's ship is in sight; required the charge for the 42-pounder guns to destroy her as quickly and completely as possible when the ships have approached near to each other: the side of the enemy's vessel* (a seventy-four) *being* $1\frac{3}{4}$ *foot thick of oak timber.*

The diameter of a 42-pounder of cast-iron being $= \cdot 557$ foot; we get $\cdot 045 \times \frac{\acute{S}+\frac{1}{2}D)\,w}{D} = 6\cdot 88306$ lbs. or 6 lbs. 14 ozs. for the weight of the charge required.

### TABLE

Containing the various charges for the 12-, 18-, 24-, 32-, 36- and 42-pounder guns, for producing the greatest effect in all cases of action: the substance or object being of oak materials, and its thickness together with the radius of the ball from 1 foot to that of 5 feet, regularly increasing by 1 in the inches.

| Nature of Ordnance. | Thickness of the Side of the Vessel, plus the Radius of the Ball. | | | |
|---|---|---|---|---|
| | 12 Inches. | 13 Inches. | 14 Inches. | 15 Inches. |
| Pounder. 12 | lbs. 1·439242 | lbs. 1·559178 | lbs. 1·679116 | lbs. 1·799052 |
| 18 | 1·928571 | 2·089285 | 2·249999 | 2·410714 |
| 24 | 2·336650 | 2·531371 | 2·726091 | 2·920813 |
| 32 | 2·830470 | 3·066343 | 3·302215 | 3·538088 |
| 36 | 3·061630 | 3·316766 | 3·571901 | 3·827038 |
| 42 | 3.393180 | 3·675949 | 3·958710 | 4·241475 |

| | 16 Inches. | 17 Inches. | 18 Inches. | 19 Inches. |
|---|---|---|---|---|
| 12 | lbs. 1·918987 | lbs. 2·838926 | lbs. 2·158863 | lbs. 2.278800 |
| 18 | 2·571428 | 2·732142 | 2·892856 | 3·053571 |
| 24 | 3·115533 | 3·310254 | 3·504975 | 3·699696 |
| 32 | 3·773960 | 4·009833 | 4·245705 | 4·481578 |
| 36 | 4·082173 | 4·337310 | 4·592445 | 4·847581 |
| 42 | 4·524240 | 4·806905 | 5·089770 | 5·372535 |

| | 20 Inches. | 21 Inches. | 22 Inches. | 23 Inches. |
|---|---|---|---|---|
| 12 | lbs. 2·398737 | lbs. 2·518674 | lbs. 2·638612 | lbs. 2·758547 |
| 18 | 3·214285 | 3·374999 | 3·535714 | 3·696428 |
| 24 | 3·894417 | 4·089137 | 4·283859 | 4·478580 |
| 32 | 4·717350 | 4·953323 | 5·189195 | 5·425068 |
| 36 | 5·102717 | 5·357853 | 5·612988 | 5·868124 |
| 42 | 5·655300 | 5·938065 | 6·220830 | 6·670262 |

| Nature of Ordnance. | Thickness of the Side of the Vessel, plus the Radius of the Ball. | | | |
|---|---|---|---|---|
| | 24 Inches. | 25 Inches. | 26 Inches. | 27 Inches. |
| Pounder. 12 | lbs. 2.878484 | lbs. 2·998420 | lbs. 3·118358 | lbs. 3·238292 |
| 18 | 3·857142 | 4·017856 | 4·178570 | 4·339284 |
| 24 | 4·673300 | 4·868021 | 5·062741 | 5·257463 |
| 32 | 5·660940 | 5·896813 | 6·132685 | 6·368559 |
| 36 | 6·123260 | 6·378396 | 6·633531 | 6·888668 |
| 42 | 6·786360 | 7·069125 | 7·351890 | 7·634655 |

| | 28 Inches. | 29 Inches. | 30 Inches. | 31 Inches. |
|---|---|---|---|---|
| 12 | lbs. 3·358228 | lbs. 3·478164 | lbs. 3·598100 | lbs. 3·718036 |
| 18 | 4·521340 | 4·682054 | 4·842768 | 5·003482 |
| 24 | 5·452184 | 5·646905 | 5·8416[illegible]6 | 6·036347 |
| 32 | 6·504432 | 5·840305 | 7·076178 | 7·312051 |
| 36 | 7·143804 | 7·398940 | 7·654076 | 7·909212 |
| 42 | 7·917420 | 8·200185 | 8·482950 | 8·765715 |

| | 32 Inches. | 33 Inches. | 34 Inches. | 35 Inches. |
|---|---|---|---|---|
| 12 | lbs. 3·837972 | lbs. 3·957908 | lbs. 4·077844 | lbs. 4·197780 |
| 18 | 5·164196 | 5·324910 | 5·485624 | 5·646338 |
| 24 | 6·231068 | 6·425789 | 6·620510 | 6·815231 |
| 32 | 7·547924 | 7·783797 | 8·019670 | 8·255543 |
| 36 | 8·164348 | 8·419484 | 8·674620 | 8·929756 |
| 42 | 9·048480 | 9·331245 | 9·614010 | 9·896775 |

| Nature of Ordnance. | Thickness of the Side of the Vessel, plus the Radius of the Ball. | | | |
|---|---|---|---|---|
| | 36 Inches. | 37 Inches. | 38 Inches. | 39 Inches. |
| Pounder. 12 | lbs. 4·317716 | lbs. 4·437652 | lbs. 4·557588 | lbs. 4·677524 |
| 18 | 5.807052 | 5.967766 | 6·128480 | 6·289194 |
| 24 | 7·009952 | 7·204673 | 7·399394 | 7·594115 |
| 32 | 8·491416 | 8·727289 | 8·963162 | 9·199035 |
| 36 | 9·184892 | 9·440028 | 9·695164 | 9·950300 |
| 42 | 10·179540 | 10·462305 | 10·745070 | 11·027835 |

| | 40 Inches. | 41 Inches. | 42 Inches. | 43 Inches. |
|---|---|---|---|---|
| 12 | lbs. 4·797460 | lbs. 4·917396 | lbs. 5·037332 | lbs. 5·157268 |
| 18 | 6·449908 | 6·610622 | 6·771336 | 6·932050 |
| 24 | 7·788836 | 7·983557 | 8·178278 | 8·372999 |
| 32 | 9·434908 | 9·670781 | 9·906654 | 10·142527 |
| 36 | 10·205436 | 10·460572 | 10·715708 | 10·970844 |
| 42 | 11·310600 | 11·593365 | 11·876130 | 12·158895 |

| | 44 Inches. | 45 Inches. | 46 Inches. | 47 Inches. |
|---|---|---|---|---|
| 12 | lbs. 5·277204 | lbs. 5·397140 | lbs. 5·517076 | lbs. 5·637012 |
| 18 | 7·092764 | 7·253478 | 7·414192 | 7·574906 |
| 24 | 8·567720 | 8.762441 | 8·957162 | 9·151883 |
| 32 | 10·378400 | 10·614273 | 10·850146 | 11·086019 |
| 36 | 11·225980 | 11·481116 | 11·736252 | 11·991338 |
| 42 | 12·441660 | 12·724425 | 13·007190 | 13·289955 |

| Nature of Ordnance. | Thickness of the Side of the Vessel, plus the Radius of the Ball. | | | |
|---|---|---|---|---|
| | 48 Inches. | 49 Inches. | 50 Inches. | 51 Inches. |
| Pounder. 12 | lbs. 5·756948 | lbs. 5·876884 | lbs. 5·996820 | lbs. 6·116756 |
| 18 | 7·735620 | 7·896334 | 8·057048 | 8·217762 |
| 24 | 9·346604 | 9·541325 | 9·736046 | 9·930767 |
| 32 | 11·321892 | 11·557765 | 11·793638 | 12·029511 |
| 36 | 12·246524 | 12·501660 | 12·756796 | 13·011932 |
| 42 | 13·572720 | 13·855485 | 14·138250 | 14·421015 |

| | 52 Inches. | 53 Inches. | 54 Inches. |
|---|---|---|---|
| 12 | lbs. 6·236692 | lbs. 6·356628 | lbs. 6·476564 |
| 18 | 8·378476 | 8·539190 | 8·699904 |
| 24 | 10·125488 | 10·320209 | 10·514930 |
| 32 | 12·265384 | 12.501257 | 12·737130 |
| 36 | 13·267068 | 13·522204 | 13·777340 |
| 42 | 14·703780 | 14·986545 | 15·269310 |

| | 55 Inches. | 56 Inches. | 57 Inches. |
|---|---|---|---|
| 12 | lbs. 6·596500 | lbs. 6·716436 | lbs. 6·836372 |
| 18 | 8·860618 | 9·021332 | 9·182046 |
| 24 | 10·709651 | 10·904372 | 11·099093 |
| 32 | 12·973003 | 13·208876 | 13·444749 |
| 36 | 14·032476 | 14·287612 | 14·542748 |
| 42 | 15·552070 | 15·834840 | 16·117605 |

| Nature of Ordnance. | Thickness of the Side of the Vessel, plus the Radius of the Ball. | | |
|---|---|---|---|
| | 58 Inches. | 59 Inches. | 60 Inches. |
| Pounder. 12 | lbs. 6·956308 | lbs 7·076244 | lbs. 7·196180 |
| 18 | 9·342760 | 9·503474 | 9·664188 |
| 24 | 11·293814 | 11·488535 | 11·683256 |
| 32 | 12·680622 | 13·916495 | 14·152368 |
| 36 | 14·797884 | 15·053028 | 15·308156 |
| 42 | 16·400370 | 16·683135 | 16·965900 |

In this Table the first column contains the nature of the ordnance, and the numbers in the other columns are their respective charges of gunpowder in pounds, when the thickness of the object to be destroyed is as specified at the top of the columns. If the thickness be given in inches, and parts of inches, take such parts of the difference between the charge for the given number of inches and the next greater; and add them to the charge first found for the given number of inches for the charge required.

The value of the decimal part of each will be had by multiplying it by 16, the number of ounces in a pound, and pointing off in the product from the right hand towards the left, as many places for decimals as are contained in the given decimal, and retaining the number on the left of the point for the ounces, increasing it by $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, or 1, when the first figure of the decimal is 2, 5, 7 or 8 respectively. This hint is merely given for those practitioners who may not be very conversant in decimals.

### Scholium.

This question is not only of the utmost importance and practically useful in naval engagements, but in several instances also of military operations; as the bursting open gates of besieged cities with promptitude and effect, and breaking up all fortifications composed of wooden materials; especially those of a splintering nature, to which the above charges apply most correctly. In the case of a naval action where the object to be penetrated is of oak substance, the ball by having a small motion when it quits the ship's side tears and splinters it excessively, breaking away large pieces before it, which are not so easily supplied in the reparation: whereas on the other hand, if the shot had any considerable velocity when it quitted the side, the effect produced would be merely a hole, which would be stopped instantly by the mechanic employed for that purpose; and indeed in a great measure by the springiness of the wood itself; for I have seen in his majesty's dock-yard at Woolwich, captured vessels having a number of shot-holes in them, almost entirely closed by the wood's own efforts; and that required nothing more than a small wooden peg or a piece of cork to stop them up perfectly: all the damage, therefore, the shot can do under such circumstances of swift celerity is merely killing those men who may chance to stand in the way of their motion.

If any object to be destroyed be so thick that it cannot be completely pierced by any common engine; or if it be of a very brittle nature, such as stone or brick, then that charge is to be used which will give the greatest velocity to the shot to produce the maximum effect. But in many cases of bombardment this charge is by no means to be preferred; for though the effect produced each individu-

al time be greater, yet in any considerable time the whole effect would be less than that from a smaller charge oftener fired, on account of the extreme heat it would give to the engine after a few discharges; and in consequence of which, greater time would be required for cooling the gun and preparing it for further service.

### Example II.

*Required the charge for a 24-pounder shot to burst open the gates of a city with the greatest ease possible, they being of* elm *one foot thick.*

Here the object to be penetrated being elm, the small letters in the general formula $\frac{Sdv^2w}{2Ds\times1600^2}\left(=\frac{(\acute{S}+\frac{1}{2}D)dv^2w}{2Ds\times1600^2}\right)$: must be made to denote the several numbers of some experiment made in the penetration of this substance. Taking, therefore, the experiment of Dr. Hutton contained in the 5th problem of his elegant Exercises on Forces, we have $d=\frac{1}{6}$ ft. $v=1500$, and $S=\frac{13}{12}$ ft.; also by the question $\acute{S}=1$ ft. $D=\cdot46$, and $w=24$ lbs. therefore

$$\frac{(\acute{S}+\frac{1}{2}D)\,dv^2w}{2Ds\times1600^2}=\frac{1\cdot23\times\frac{1}{6}\times1500^2\times24}{2\times\cdot46\times\frac{13}{12}\times1600^2}=\frac{830\cdot25}{191\cdot36}=4\cdot33868\text{lbs.}$$

or 4lbs. $5\frac{1}{2}$ozs. nearly the weight of the charge required in this case.

Retaining the experiment of Dr. Hutton as a standard for all cases where the substance to be penetrated is of elm, we shall have by reduction $\frac{(\acute{S}+\frac{1}{2}D)\,dv^2w}{2Ds\times1600^2}=\cdot0676\times\frac{(\acute{S}+\frac{1}{2}D)w}{D}$: the charge for any piece the diameter of whose shot is D, and weight $w$; $\acute{S}$ being the thickness of the object as before.

It is not unworthy of remark, that the gates of a besieged place, or any like things, might be effectually broken open by the gun itself, charged only with powder; by placing it close to the gates with its muzzle from them; the momentum of recoil being generally sufficient to force such objects completely.

## No. 38.

### *Of Telegraphic Communication.*

[The present state of our national affairs renders the subject of Telegraphic communication an object of considerable interest; and as it comports fully with the extensive range of information which the Emporium contemplates, this subject will be continued in a few of the succeeding numbers. The English word Telegraph, is derived from two Greek words, τηλε, (tele) procul, and γράφω, (grapho) scribo, implying, to write or correspond at a distance. Ed.]

### *Brief Historical Sketch of the Telegraph.**

WE apprehend that some contrivance which, to a certain extent, answered the end of the interesting and important machine, universally known by the appellation of *Telegraph*, and which is of modern application and improvement, was known to the ancients at a much earlier period than many of our readers may have conceived. And when it is considered that the object proposed is, to obtain an intelligible figurative language which may be distinguished at a distance. and by which the obvious delay in the dispatch of orders or information by messenger may be avoided; and that the nature of this work requires us to present all the useful and interesting information in our power relative to each of the topics which come under our review, we presume that a brief historical sketch of that instrument will not be unacceptable to many of our readers.

* Retrospect, v. 5. p. 335. Editorial observations on the subject of Major Le Hardy's Telegraph.

As the name is descriptive of a contrivance by which information is almost instantaneously conveyed to a considerable distance, whenever we find a circumstance of this nature recorded, it is natural to conclude that it was effected by some agent possessing similar qualities. It is generally regarded as a well-authenticated fact, that the burning of Troy was known in Greece a very short time after it happened, and long before it was possible for any person to have arrived there from the scene of conflagration. One of the Greek plays opens with a scene in which a watchman descends from a tower in Greece with the news that Troy was taken. He thus expresses himself: "I have been looking out these ten years to see when that would happen, and this night it is done:" a proof that the ancients possessed some mode of conveying information very quickly to a great distance; but what that mode was, it is not so easy to determine. When the Chinese courtiers travel to distant parts of the empire, signals are made by means of fire from one day's journey to another, in order that preparations may be made for their reception. In most barbarous nations it was customary to give the alarm of war by fires lighted on the tops of hills; and Polybius styles the instruments used by the ancients for communicating intelligence in this manner, *pyrsiæ*, because the signals were made by means of fire. A new method of accomplishing this object was invented by Cleoxenus (some say by Democritus,) and much improved by Polybius. He divided the Greek alphabet into five parts, and expressed the letters on boards in five columns. The order in which these letters were to be taken was signified by torches held up in certain positions, previously agreed upon by the parties.

Neither this last-mentioned method, nor any other known to the ancients, however, appears to have been carried into general use; nor have we any account of any

modern invention for the same purpose previous to the Marquis of Worcester's, contained in his "*Century of Inventions,*" which was published in 1663. In this work he affirms that he had discovered "a method by which, at a window, as far as the eye can discover black from white, a man may hold discourse with his correspondent, without noise made or notice taken; being according to occasion given, or means afforded, *ex re nata,* and no need of provision beforehand; though much better if foreseen, and course taken by mutual consent of parties." This means of correspondence he also asserts to have been rendered so perfect that it could be put in practice "by night as well as by day, though as dark as pitch is black." On the 21st of May 1684, Dr. Hooke, so much celebrated for his mechanical genius, delivered a discourse to the Royal Society on the method of communicating one's mind at a great distance. In this discourse he asserted the possibility of conveying intelligence from one place to another at the distance of 30, 40, 100, 120, &c. miles, "in as short a time almost as a man can write what he would have sent;" and laid down directions for accomplishing it. The whole of this ingenious paper was published in Derham's Collection of Dr. Hooke's "*Experiments and observations,*" and from which it appears that his contrivance was little inferior to several that have been lately proposed for the same purpose. William Amontons, an ingenious French philosopher, about the year 1702, likewise invented a method of conveying information from one place to another by signals; and it is probable without any knowledge of what had been previously advanced on the same subject by the Marquis of Worcester and Dr. Hooke, as his method seems to be much inferior to that pointed out by this last gentleman.

None of these inventions, however, were applied to purposes of utility before the French revolution, when

M. Chappe, towards the end of 1793, invented an instrument of a similar nature, and applied to it the name of *telegraph ;* whether or not he knew any thing of the inventions of Dr. Hooke and Amontons it is impossible to say. The first chain of telegraphs formed a communication between the Louvre at Paris, and Lisle, a distance of about thirty-five leagues, near which town the French army then was. The first description of this instrument is said to have been brought from Paris to Frankfort on the Maine by a former member of the parliament of Bourdeaux, who had seen that which was erected at the mountain of Belville, near Paris. Two working models of it were made at Frankfort, and sent by Mr. W. Playfair to the Duke of York: and hence the plan and alphabet of the machine came into England. M. Chappe's contrivance consisted chiefly of an upright post bearing a transverse bar about 10 or 12 feet in length, and 9 inches broad, moveable about a pivot in its centre; to each extremity of this bar an arm of about 3 feet long was attached by a moveable joint: by means of these three the combination of movement was very extensive, simple, and easy to be performed. A number of arbitrary positions were fixed to denote the letters of the alphabet; and these being always made precisely in the same manner by means of the mechanism employed to work the arms, intelligence was conveyed with astonishing accuracy and rapidity.

In consequence of this information various experiments were made in this country,* and a communication by means of a chain of signals was soon established from the Admiralty-office to the sea-coast. The telegraph adopted for this purpose consisted of six octagonal boards, each moveable about an axis, and capable of being placed either vertically or horizontally, so as to be either visible or invisible at the nearest station at plea-

* Great Britain.

sure. These six boards are capable of exhibiting thirty-six changes by the most simple and easy mode of working them; and by these the letters of the alphabet and the numeral cyphers are denoted. This telegraph, however, was by no means considered as being free from objections and inconveniences, and various contrivances for remedying these have been invented since that period. To give an account of all these would greatly exceed our limits; we shall, therefore, content ourselves with mentioning a few of the principal of them. Mr. John Garnet proposed a very simple and ingenious instrument, which consisted merely of a bar or plank, moveable about a centre, round which a circle was described, having the letters of the alphabet and figures depicted round its circumference. An index which corresponded with the bar enabled the operator to set it to any letter or figure he wished to communicate. A wire was fixed across the tube of the telescope used by the observer, which was to be brought to coincide with, or to be parallel to the bar; then the letter or figure to be communicated was denoted by a small index at the eye end of the telescope, which contained a circle similar to that encompassing the centre of motion of the bar. Another ingenious improvement was proposed in the Gentleman's Magazine: it consisted of a semicircle of twelve feet radius: this was to be properly elevated, divided into 24 equal parts, and each of these perforated with a circular opening of six inches in diameter. These apertures beginning from the left, denoted the letters of the alphabet, except K, J, V, X, and Q, which were omitted: the remainder of the holes were reserved for signals. The communications to be made in the day were pointed out by means of an index, and in the night by lamps. None of the preceding telegraphs, however, appear to exceed, either in simplicity, cheapness, or facility of working, that described by J. N. Esq.

in vol. i. of the Repertory of Arts, Old Series. For a nocturnal telegraph it consists of four large patent reflectors, situated in the same plane and parallel to the horizon, but sufficiently elevated above it. Each of these reflectors is susceptible of being elevated or depressed at pleasure by means of winches, and the letters of the alphabet are denoted by the changes. When this telegraph is used in the day, gilt balls, or any other conspicuous objects, are to be used instead of the reflectors. Captain Pasley, of the Royal Engineers, also invented two telegraphs. one of them to be used by day and the other by night:—for a description of these see our fourth volume, page 6.*

Two methods have generally been adopted in communicating telegraphic information: in the one, each signal represents a single letter; in the other, a complete sentence. This last has generally been thought to possess an advantage over the other in point of expedition, but it is only partial in its application; and we have already stated it as our opinion, that the general elements of language only should be transferred, and that every real improvement in the telegraphic art must tend to facilitate the execution of this object.

*(To be continued.)*

## No. 39.

### *On Signals made by Fire.* †

(With a Plate.)

THE subject which Polybius here treats is curious enough in itself; and besides, it bears so near a relation to the facts I am now relating, as to excuse a digression, that will not be of a great length, and which the reader

* These different forms of the Telegraph will be given in subsequent numbers of the Emporium. Ed.

† Rollin's Ancient History, v. 6, p. 321. 9th edit. Dundee.

may pass over if he finds it tedious. I shall repeat it almost literally as I find it in Polybius. Livy, in his account of the particulars above related, and which he copied almost verbatim from Polybius,* mentions the same signals made by fire: but then he only hints at them, because as they were not invented by the Romans, consequently this was a subject which did not relate so immediately to the history he was writing. But this artifice of the signals, which is a part of the art of war, belongs properly to the history of the Greeks, and shows to how great a perfection they had carried all the parts of that noble art, the judicious reflections they had formed in all things relative to it, and the astonishing progress they had made,† in respect to the construction of machines of war, different kinds of armour, and military signals.

As the making signals by fire, says Polybius, though of great use in war, has hitherto not been treated with any accuracy, I believe it will not be proper to pass over them superficially, but to dwell a little upon that head, in order to give my readers a more perfect idea of it.

It is a truth universally acknowledged, that opportunity is of great advantage in all things, but especially in war. Now, among the several things which have been invented to enable men to seize it, nothing can be more conducive to that end than signals made by fire. Whether transactions have happened but a little before, or are then transacting, they may, by this method, be very easily made known, at places distant three or four days journey from where they happened, and sometimes at a

* Philippus, ut ad omnes hostium motus posset occurrere, in Phocidem atque Eubœam, et Peparethum mittit, qui loca alta eligerent, unde editi ignes apparerent: ipse in Tisæo (mons est in altitudinem ingentem cacuminis editi) speculam posuit, ut ignibus procul sublatis, signum, ubi quid molirentur hostes, momento temporis acciperet. Liv. l. xxviii. n. 5.

† Polyb. l. x. p. 614—618.

still greater distance; and by this help the necessary aids may be obtained in time.

Formerly, this method of giving notice was of very little advantage, because of its too great simplicity; for, in order to the making use of it, it was necessary that certain signals should be agreed upon; and as events are infinitely various, it was impossible to communicate the greatest part of them by this method. As for instance, not to depart from the present history, it was very easy to make known, at a distance, that a fleet was arrived at Oræa, at Peparethos, or at Chalcis, because the parties whom it concerned had foreseen this, and accordingly had agreed upon such signals as might denote it: but an unexpected insurrection, a treason, an horrid murder committed in a city, and such like accidents as happen but too often, and which cannot be foreseen; this kind of events, which require immediate consideration and remedy, cannot be signified by a beacon; for it is not possible to agree upon a signal for such events as it is impossible to foresee.

Æneas,* who wrote a treatise on the duties of a general, endeavoured to complete what was wanting on this occasion; but he was far from succeeding so well as could have been wished, or as he himself had proposed, of which the reader may now judge.

Those, says he, who would give signals to one another, upon affairs of importance, must first prepare two vessels of earth, exactly equal in breadth and depth; and they need be but four feet and an half deep, and a foot

* Æneas was cotemporary with Aristotle. He wrote a treatise on the art of war. Cineas, one of Pyrrhus's counsellors, made an abridgment of it. Pyrrhus also wrote on the same subject. Ælian. Tact. cap. 1. Cicero mentions the two last in one of his epistles. "Summum me ducem literæ tuæ reddiderunt. Plane nesciebam te tam peritum esse rei militaris. Pyrrhi te libros et Cineæ video lectitasse." Lib. ix. Epist. 25. ad Papir. Pœtam.


*Signals by Fire.*

*Emporium of Arts & Sciences. Vol. I Pl. 8.*

and an half wide. They then must take pieces of cork, proportioned to the mouth of these vessels, but not quite so wide, that they may be let down with ease to the bottom of these vessels. They next fix in the middle of this cork a stick, which must be of equal size in both these vessels. This stick must be divided exactly and distinctly by spaces of three inches each, in order that such events as generally happen in war may be written on them. For example, in one of these intervals the following words may be written: "A body of horse are marched into the country." On another, "A body of infantry, heavily armed, are arrived hither." On a third, "Infantry lightly armed." On a fourth, "Horse and foot." On another, "Ships." Then, "Provisions:" and so on, till all the events which may probably happen in the war that is carrying on are written down in these intervals.

This being done, each of the two vessels must have a little tube or cock of equal bigness, to let out the water in equal proportion. Then the two vessels must be filled with water; the pieces of cork, with their sticks thrust through them, must be laid upon them, and the cocks must be opened. Now it is plain that as these vessels are equal, the corks will sink, and the sticks descend lower in the vessels, in proportion as they empty themselves. But to be more certain of this exactness, it will be proper to make the experiment first, and to examine whether all things correspond and agree together by an uniform execution on both sides.

When they are well assured of this, the two vessels must be carried to the two places where the signals are to be made and observed; water is poured in, and the corks and sticks are put in the vessels. In proportion, as any of the events which are written on the sticks shall happen, a torch or other light is raised, which must be held aloft till such time as another is raised by the party

to whom it is directed. This first signal is only to give notice that both parties are ready and attentive; then the torch or other light must be taken away, and the cocks set open. When the interval, that is, that part of the stick where the event of which notice is to be given is written, shall be fallen to a level with the vessels, then the man who gives the signal lifts up his torch; and, on the other side, the correspondent signal maker immediately turns the cock of his vessel, and looks at what is writ on that part of the stick which touches the mouth of the vessel; on which occasion, if every thing has been executed exactly and equally on both sides, both will read the same thing.

Although this method differs from that which was practised in early ages, in which men agreed only upon a single signal, which was to denote the event the other party desired to be informed of, and which had been agreed upon, it nevertheless was too vague and indeterminate; for it is impossible to foresee all the accidents that may happen in a war; and though they could be foreseen, there would be no possibility of writing them all on a piece of stick. Besides, when any unexpected accident should happen, how could notice be given of it according to this method? To this I may add, that the inscription on the stick is no ways exact and circumstantial. We are not told how many horse and foot are come; what part of the country they are in; how many ships are arrived; nor the quantity of provisions they have: for before these several particulars could be written on the stick, they must have been foreseen, which was altogether impossible, though most essential; and how can succours be sent, when it is not known how many enemies are to be opposed, nor in what part of the country they are? How must a party either confide in or doubt their own strength? In a word, how will they know

what to do, when they are not told how many ships, or what quantity of provisions are come from the enemy?

The last method was invented by Cleoxenes, which others ascribe to Democlitus; however we have improved it, says Polybius, who continues the sole speaker upon this head. This fixes every circumstance, and enables us to give notice of whatsoever happens. The only thing required is great care and exactness. This method is as follows:

The 24 letters of the alphabet must be taken and divided into five parts; and these must be fixed on a board, from top to bottom, in their natural order in five columns; five letters in each column, the last excepted, which is to have but four.

The alphabet being disposed in this manner, the man who is to make the signal must begin by showing two torches or lights; and these he must hold aloft till the other party has also shown two lights. This first signal is only to show that both sides are ready, after which the lights must be removed.

The affair now is, to make the other party read in this alphabet the advices we want to acquaint them with. The person who gives the signal shall hold up torches to his left, in order to denote to the correspondent party from which of the columns he must take letters, to write them down in proportion as they shall be pointed out to him; so that if it is the first column, he only holds up one torch, if the second, he shows two, and so on, and always to the left. He must do the same to the right hand, to point out to the person who receives the signal, which letter in the column he must observe and write down. This both parties must agree upon between them.

These several things being fixed, and each of them got to his post, the man who gives the signal must have a geometrical instrument with two tubes, in order that he

may know by one of them the right, and by the other the left of him who is to answer. The board must be set up near to this instrument; and to the right and left a solid must be raised ten feet broad, and about the height of a man; in order that the torches which shall be lifted up over it, may spread a strong clear light; and that when they are to be lowered, they may be entirely hid behind them.

All things being thus disposed on each side, I will suppose, for instance, that advice is to be given that "An hundred Cretans, or Kretans, are gone over to the enemy." First, he must make choice of such words as will express what is here said in the fewest letters possible, as "Cretans, or Kretans,* an hundred have deserted;" which expresses the very same idea in much fewer letters.

The first letter is K, which is in the second column. Two torches must therefore be lifted to the left, to inform the person who receives the signal, that he must look into the second column. He then must lift up five torches to the right, to denote that the letter sought for is the fifth of the second column, that is K.

Afterwards, four torches must be held up to the left, to point out the P,† which is in the fourth column; then two to the right, to denote that this letter is the second of the fourth column. The same must be observed with respect to the rest of the letters.

By this method, every event that comes to pass may be denoted in a fixed and determinate manner. The reason why two sets of lights are used, is because every letter must be pointed out twice; the first to denote the column to which it belongs, and the second to show its place in order in the columns pointed out. If the persons employ-

* The words are disposed in this manner in the Greek.

† This is the capital letter R in the Greek tongue.

ed on these occasions observe the rules here laid down, they will give exact notice: but it must be practised a long time before they will be able to be very quick and exact in the operation.

This is what is proposed by Polybius, who, it is well known, was a great soldier and politician, and for this reason his hints ought to be valued. They might be improved and put in practice on a great many occasions. These signals were employed in a mountainous country.

A pamphlet was lent me, printed in 1702, and entitled, "The art of making signals both by sea and land." The pamphlet was dedicated to the king, by the Sieur Marcel, commissioner of the navy at Arles. This author affirms, that he had communicated several times, at the distance of two leagues (in as short a space of time as a man could write down and form exactly the letters contained in the advice he would communicate,) an unexpected piece of news that took up a page in writing.

I cannot say what this new invention was, or what success it met with; but in my opinion such discoveries as these ought not to be neglected. In all ages and nations, men have been very desirous of finding out and employing methods for receiving or communicating speedy advices; and of these, signals by fire are one of the principal.

* In the fabulous times, when the fifty daughters of Danaus murdered all their husbands in one night, Hypermnestra excepted, who spared Lynceus, it is related, that both flying, and each being arrived at a place of safety, they informed one another of it by signals made by fire; and that this circumstance gave rise to the festival of torches established in Argos.

Agamemnon, at his setting out for the Trojan expedition, had promised Clytemnestra, that the very day the

* Pausan. l. ii. p. 130.

city should be taken, he would give notice of the victory by fires kindled for that purpose. He kept his word, as appears from the tragedy of Æschilus, which takes its name from that prince: where the she-sentinel, appointed to watch this signal, declares she had spent many tedious nights in that uncomfortable post.

We also find* by the writings of Julius Cæsar, that he himself used the same method.

Cæsar gives us an account of another method in use amongst the Gauls. Whenever any extraordinary event happened in their country, or they stood in need of immediate succour, they gave notice to one another by repeated shouts, which were catched from place to place; so that the massacre of the Romans in Orleans, at sunrise, was known by eight or nine o'clock in the evening at Auvergne, 40 leagues from the other city.

† We are told of a much shorter method. It is pretended that the king of Persia, when he carried the war into Greece, had posted a kind of sentinels at proper distances, who communicated to one another, by their voices, such news as it was necessary to transmit to a great distance; and that advice could be communicated from Athens to Susa (upwards of 150 leagues) in 48 hours.

It is also related, that a‡ Sidonian proposed to Alexander the Great an infallible method for establishing a speedy and safe communication between all the countries subject to him. He required but five days for giving notice, from so great a distance as between his hereditary kingdom, and his most remote conquest in India: but the king, looking upon this offer as a mere chimera, rejected it with contempt: however, he soon repented it,

* Celeriter, ut ante Cæsar imperaverat, ignibus significatione facta, ex proximis castellis eo concursum est. Cæs. Bell. Gall. l. ii.

† Cœl. Rhodig. l. xviii. c. 8.

‡ Vigenere, in his remarks on the seventh book of Cæsar's wars in Gaul, relates this without citing directly the author.

and very justly; for the experiment might have been made with little trouble to himself.

* Pliny relates another method, which is not altogether improbable. Decimus Brutus defended the city of Modena besieged by Antony, who prevented his sending the least advice to the consuls, by drawing lines round the city, and laying nets in the river. However, Brutus employed pigeons, to whose feet he fastened letters, which arrived in safety wherever he thought proper to send them. Of what use, says † Pliny, were Antony's intrenchments and sentinels to him? Of what service were all the nets he spread, when the new courier took his rout through the air?

Travellers relate, that to carry advices from Alexandria to Aleppo, when ships arrive in that harbour, they make use of pigeons who have young ones at Aleppo. Letters, containing the advices to be communicated, are fastened about the pigeons' necks, or feet; this being done, the pigeons take wing, soar to a great height, and fly to Aleppo, where the letters are taken from them. The same method is used in many other places.

## *Description of the Instruments employed in Signals made by Fire.*

Mr. Chevalier, mathematical professor in the royal college, a fellow-member with me, and my particular friend, has been so good as to delineate, at my request, the figure of the instrument mentioned by Polybius, and to add the following explication of it.—Plate 8.

In this manner I conceive the idea I have of the instrument described by Polybius, for communicating advices at a great distance, by signals made by fire.

* Plin. l. vii. c. 37.

† Quid vallum, et vigil obsidio, atque etiam retia amne prætexta profuere Antonio, per cœlum eunte nuntio?

*a b* is a beam about four or five feet long, five or six inches broad, and two or three inches thick. At the extremities of it are, well dove-tailed and fixed exactly perpendicular in the middle, two cross pieces of wood, *c d*, *e f*, of equal breadth and thickness with the beam, and three or four feet long. The sides of these cross pieces of timber must be exactly parallel, and their upper superficies very smooth. In the middle of the surface of each of these pieces, a right line must be drawn parallel to their sides; and consequently these lines will be parallel to one another. At an inch and a half, or two inches, distance from these lines, and exactly in the middle of the length of each cross piece, there must be driven in very strongly, and exactly perpendicular, an iron or brass screw, whose upper part, which must be cylindrical, and five or six lines in diameter,* shall project seven or eight lines above the superficies of these cross pieces.

On these pieces must be placed two hollow tubes or cylinders, *g h*, *i k*, through which the observations are made. These tubes must be exactly cylindrical, and formed of some hard, solid metal, in order that they may not shrink or warp. They must be a foot longer than the cross pieces on which they are fixed, and thereby will extend six inches beyond it at each end. These two tubes must be fixed on two plates of the same metal, in the middle of whose length shall be a small convexity, of about an inch round. In the middle of this part must be a hole exactly round, about half an inch in diameter; so that applying the plates on which these tubes are fixed upon the cross pieces of wood *c d*, *e f*, this hole must be exactly filled by the projecting and cylindrical part of the screw which was fixed in it, and in such a manner as

* Twelfth part of an inch.

to prevent its play. The head of the screw may extend some lines beyond the superficies of the plates, and in such a manner as that those tubes may turn, with their plates, about these screws, in order to direct them on the boards or screens *p q*, behind which the signals by fire are made, according to the different distances of the places where the signals shall be given.

The tubes must be blacked within, in order that, when the eye is applied to one of their ends, it may not receive any reflected rays. There must also be placed about the end, on the side of the observer, a perforated ring, the aperture of which must be three or four lines; and place at the other end two threads, the one vertical, and the other horizontal, crossing one another in the axis of the tube.

In the middle of the beam *a b* must be made a round hole, two inches in diameter, in which must be fixed the foot *l m n o*, which supports the whole machine, and round which it turns as on its axis. This machine may be called a rule and sights, though it differs from that which is applied to circumferenters, theodolites, and even geometrical squares, which are used to draw maps, take plans, and surveys, &c. but it has the same uses, which is to direct the sight.

The person who makes the signal, and he who receives it, must have the like instrument; otherwise the man who receives the signal could not distinguish whether the signals made are to the right or left of him who makes them, which is an essential circumstance, according to the method proposed by Polybius.

The two boards or screens *p q*, which are to denote the right and left hand of the man who gives the signals, or to display or hide the fires, according to the circumstance of the observation, ought to be greater or less, and nearer or further distant from one another, according as

the distance between the places where the signals must be given and received is greater or less.

In my description of the preceding machine, all I endeavoured was, to explain the manner how Polybius's idea might be put in execution, in making signals by fire; but I do not pretend to say, that it is of use for giving signals at a considerable distance ; for it is certain, that, how large soever this machine be, signals made by two, three, four, and five torches, will not be seen at five, six, or more leagues distance, as he supposes. To make them visible at a greater distance, such torches must not be made use of, as can be lifted up and down with the hand, but large wide spreading fires, of whole loads of straw or wood ; and consequently, boards or screens of a prodigious size must be employed to hide or eclipse them.

Telescopes were not known in Polybius's time ; they were not discovered or improved till the last century. These instruments might have made the signals in question visible at a much greater distance than bare tubes could have done : but I still doubt, whether they could be employed to the use mentioned by Polybius, at a greater distance than two or three leagues. However, I am of opinion, that a city besieged might communicate advice to any army sent to succour it, or give notice how long time it could hold out a siege, in order to taking proper measures ; and that, on the other side, the army sent to its aid might communicate its designs to the city besieged, especially by the assistance of telescopes.

## No. 40.

### *Description of a cheap and efficacious Ventilator for preserving Corn on Ship-board. By* THOMAS SOUTH, *Esq.**

(With a Plate.)

THE importation of grain is a precarious traffic. The produce of distant countries, or even of those near home, when long in collecting, or long detained on ship-board, is subject to heat, soon becomes fetid, and is often so far spoiled and depreciated in its value as to sell for less than the original cost. Hence the merchant, overwhelmed with losses, regrets his patriotism, grows shy of importation, and, unless invited by a certainty of gain, drops the trade, even whilst the nation stands in need of supplies.

The remedy here proposed is a simple, cheap, and, I trust, efficacious method of ventilating grain whilst confined on ship-board; sufficient, I presume, to keep it sweet and marketable after sustaining a tedious voyage.

### *Description of the Ventilator, with References to the Figures thereof.* (See Plate 9, fig. 1 to 7.)

Fig. 1, is a cylindrical air-vessel or forcing-pump, of lead, tin, or other cheap metal; its internal diameter being ten inches, and its length three feet; having a crutch-handled piston to work with, and an iron nosle, viz. a hollow inverted cone, two feet long, to condense the air, and increase its power in its passage downwards. This cylinder should be riveted or screwed, by means of an iron collar or straps, to the deck it passes through, both

* Tilloch, v. 5, p. 393. From the Letters and Papers of the Bath and West-of-England Society for the Encouragement of Agriculture, &c.

above and below, as at *a a*; and should be further secured by some hold-fast near *b*, to keep it steady in working.

Fig. 2, is a bottom of wood, four inches and a half thick, with a projecting rim at its base, for the metal cylinder to rest on, when cemented and screwed to the wood. The centre of this bottom is excavated, for the reception of the crown of the nosle. In the same figure the nosle is represented with its crown like a bowl-dish, to condense the air gradually, without resistance, in its advance to the more contracted base of the inverted cone, i. e. the top or entrance of the nosle. About two-thirds down this nosle may be fixed a male screw, as *c c*, for the purpose hereafter mentioned.

N. B. The forcing-pump should be cased in wood, to protect it from outward bruises, which would prevent the working of the piston, and ruin its effects. The leather round the embolus should be greased when used.

Fig. 3, is a crutch-handle, fastened to the embolus A by its iron legs B, B.—A is a cylinder of wood, cased with leather, so as to fit well, but glide smoothly in the metal cylinder; having an opening as large as its strength will permit, for the free access of atmospheric air. C is a valve, well leathered on its top, and yielding downwards to the pressure of the air when the piston is raised up. D is a cross bar of iron, to confine the valve, so that it may close instantly on the return of the piston downwards.

Fig. 4, is a tin pipe or tube, of less than four inches diameter, and of such length as, when fixed to the base of the cylinder, Fig. 1, shall admit the nosle *d*, Fig. 2, to within half an inch of the valve E, at the bottom of the wooden cylinder F, in Fig. 4; which valve E will then yield to the pressure of air condensed in its passage through the nosle, and deliver it into the pipes below.

This valve must be well leathered on its upper surface, and fastened with an hinge of leather to the cylinder it is meant to close: affixed to its bottom is the spindle G, passing through a spiral spring H, which, being compressed on the descent of the valve, will, by its elasticity, cause it to rise again, close the aperture above, and retain the air delivered beneath it. On connecting this cylinder with the upper end of the nosle, at *e e*, Fig. 2, we must carefully prevent any lapse of air that way, by a bandage of oakum smeared with wax, on which to screw the cylinder, like the joints of a flute, air-tight. I is a bar of iron, having a rising in its centre, wide enough for the spindle to play through, but at the same time sufficiently contracted to prevent the passage of the spiral spring.

Fig. 5, is an assemblage of tin pipes, of any lengths, shaped suitably and conveniently to their situation in the ship, to the form of which, when shut into one another, they must be adapted; observing only, that the neck be straight for a length sufficient to admit the lower end of the cylinder, Fig. 4, as high as the letter F, or higher.

Fig. 6. To the middle pipe, which runs along the bottom, should be fixed a perpendicular one, fully perforated, to convey the air more readily into the centre of the heap; and this may have a conical top, as represented in the plate, perforated with a smaller punch to prevent the air from escaping too hastily. In large cargoes, two or three of these perpendiculars may be necessary; and each should be well secured by an iron bar *g*, screwed down, to prevent their being injured by the shifting of the cargo in stormy weather or a rolling sea. The top of the conical cap of these pipes may reach two-thirds up the cargo.

Fig. 7, is a valve of the same construction as that represented in Fig. 4, but inclosed in a tube of brass, having

a female screw at *f f*, adapted to the male screw *c c*, on the nosle Fig. 2, and may then be inserted into the head of the pipe Fig. 5. This will add to the expense; but, in a large apparatus, is to be preferred, as a more certain security from lapse of air, than the junction of the tube Fig. 4, to the neck *e e* in Fig. 2.

N. B. *e e* is a neck of wood, making a part of the bottom Fig. 2, whereon to secure the tube Fig. 4, when applied to the nosle. The joints of the pipes, when put together for use, should be made air-tight, by means of bees-wax or some stronger cement, till they reach the bottom of the vessel, when there is no further need of this precaution. The horizontal pipes should run by the side of the kelson the whole length of the hold. The tin plates of which K is made, should be punched in holes, like the rose of a watering-pot, in two or three lines only, at most, and then formed into a tube, with the rough side outwards. L may have four or five lines of the like perforations. M, and the rest, should gradually increase in their number as they advance towards the middle of the hold, and continue fully perforated to the last pipe, which should be closed at its end to prevent the ingress of the corn. It is the centre of the cargo which most requires ventilating, yet air should pervade the whole. Like the trade-winds, it will direct its course to the part most heated, and, having effected its salutary purpose there, will disperse itself to refresh the mass.

Where the hatches are close-caulked, to prevent the influx of water, vent-holes may be bored in convenient parts of the deck, to be bunged up and opened occasionally, from whence the state of the corn may be known by the effluvia which ascend when the ventilator is working.

The power of the ventilator is determined by the square of its diameter multiplied into the length of the

stroke, and that again by the number of strokes in any given time.

To find the area of a circle, and the solidity of a cylinder raised on that circle, Archimedes gives the following proportion :—

As 1 is to .785398 decimal parts, so is the square of the diameter to the area of the circle.

And, as 1 is to .785398, so is the square of the diameter, multiplied by the height, to the solidity of the cylinder.

The cubical contents, both of the cylinders and tubes, are found in the same manner; their difference consisting not in shape, but solidity, the latter being hollow.

Then, to find the contents of a cylindrical vessel whose internal diameter is ten inches, multiply that into itself, and the square thus obtained, multiplied by .7854, will give the contents of the circle in cubic inches; which, multiplied again by twenty-four inches or lengths of the stroke, being the proportion of the barrel filled with air, gives in cubic inches the amount of each discharge on the descent of the piston. As thus :

Inches.
Internal diameter of the pump or tube 10
× 10
———
= 100,or square of the diameter;
which, multiplied by .7854, to bring the contents of the square to the contents of the circle.
———
Which, multiplied by the length of the stroke, } 78,5400 Contents of the area of the circle.
24 inches, produces 1884 cubic inches.
———
3141600
1570800
———
1884.9600

which, divided by 231)188÷.9600(8.1600 gallons, which is $\frac{16}{100}$ths more than 8 gallons at a stroke; allow these decimals for waste of air
*viz.* the number of cubic inches in a wine gallon, quotes 8 galls.
———
369
———
1386
———

in each stroke, and 600 strokes to be made in a minute.

Then 8 gallons discharged at a stroke,
multiplied by 60, the number of strokes,

amounts to 480 gallons *per* minute ;
which multiplied by 60, the minutes in an hour, produces
28800 gallons in that time ;
and that, divided by 252)28800(=114.3 tons. (The number of gallons in a ton, both wine and ship measure) quotes 114 tons in an hour.

Then, suppose the area of the hold of a ship to be = 120 tons, and, when freighted, the interstices between the grains, together with the area between the surface of the corn and the underside of the deck = 5 tons = to the quantity of mephitic air confined ; such being the lightest fluid, the major part of it would, soon after the commencement of the operation, be forced, by the atmospheric air, to vent itself at the holes provided for that purpose ; and the remainder of the hour being employed in the like ventilation, five tons of fresh air would pass above twenty times repeatedly amidst the grains, to cool, refresh, and sweeten the cargo. A purification thus administered once in eight-and-forty hours, would, I conceive, be amply sufficient to preserve the corn from taint or injury, be the voyage ever so tedious ; and unless it should by neglect have overheated and grown together, or settled too close, the labour would be that of a boy only ; for the dairy-girl at her churn works harder than he otherwise need to do at this.

My air-vessel is, for the sake of cheapness, confined to the narrow diameter of ten inches ; but, as the contents of circles are proportionate to the square of their diameters, by enlarging that, you increase their power accordingly ; wherefore, by extending the diameter to fourteen inches, the contents will be nearly doubled ; and, by adding ten inches more to the length of the stroke, you almost treble the discharge of No. 1, and obtain a

power capable of ventilating a cargo of 400 tons within the hour. But the air-vessel must be lengthened; the pipes at the same time enlarged; the metal of which the whole is constructed be in substance proportionable; and the labour be that of a man, or perhaps two upon occasion.

A ventilator, on the plan and dimensions here proposed, would come within the compass, I should think, of five or six guineas. One on the larger scale, caused by the increased substance of the metal, and the extra size and length of the pipes, might amount to twenty; which, in either, is under fourpence per quarter on the first cargo; and as they will last many years if well painted, and, when not in use, taken to pieces and put carefully by, I flatter myself it is an experiment well worth trial; particularly if a premium be offered to the ship-owner, who, by means of such machine, imports his corn pure and untainted from a distant land.

*Objections made to the supposed Effect of the Ventilator, overruled, it is hoped, by the Considerations which follow them.*

First, The holes pierced in the tin tubes which are to lie under the corn, seem capable of issuing (especially if an effort be made upon them) a much larger quantity of air than the forcing-pump will supply in a given time. Consequently, a given quantity of these holes, under a given pressure, will be capable of issuing the whole supply of air, without any assistance from the remainder.

Secondly, If these positions are just, it must happen, that if a cargo of corn be unequally circumstanced in relation to its permeability, the whole of the air discharged by the pump will issue through the *more* permeable parts of it, without affecting, in any degree, the *less* permeable ones.

Thirdly, In cargoes heated in any degree, and in those infected by that worm which fastens grains together by a web, the parts most affected become much more close and densely packed together than the rest, either by the swelling of the heated grains, or by the web and dung of the worms which occupy the intervals between the grains.

If so, the parts of a cargo which require the most ventilation will receive the least; but, in all cases, it seems likely that the air discharged will not regularly permeate the whole of the cargo, but will pass through the parts where the grain lies lightest, and leave untouched those parts where it is most closely packed together.

### *Answer to the preceding Objections.*

Though the holes appear numerous, they must be small, lest the corn gain admission; and many (especially of the uppermost) will be nearly, if not totally, stopped by the pressure of the grains upon them. Besides, the pipes which convey the air towards the centre are not meant to be so fully perforated as those at and beyond it; and all may be still less so, if in practice found necessary. But as the quantity of air delivered by the forcing-pump within five seconds of time is equal to the contents of sixty * feet of four-inch pipe within the first minute, the

* Thus calculated:

| | |
|---|---|
| | Inches. |
| 60 feet | 4 |
| × 12 inches | × 4 |
| Produces 720 inches as a multiplier. | 16 the square of the diameter of the pipe. |
| | × ,7854 |
| | = 12,5664 or area of the circle. |
| | × 720 length of the pipe in inches. |

Which, divided by 231)9047,8080(=39,1679 gallons and decimal parts, the whole capacity of 60 feet of pipe.

air (notwithstanding the manifold perforations, obstructed as it is in meandering through a mass so nearly compacted as the bottom of the cargo must necessarily be by the pressure of the heap above,) will undoubtedly reach to the end of the pipes, and consequently affect the cargo even there.

Be it further observed, that the flux of air compressed into an half-inch stream, in its passage through the nosle, to enable it to overcome the resistance of the spiral spring H, no sooner passes the valve E, than it expands itself to the compass of the pipe; by which expansion, and extension (at the same time) forwards, its power becomes so weakened, that small egress only will be made, till the pipes are filled with a fluid more dense than atmospheric air, which will then, as is justly noticed, issue where it finds the least obstruction, unless attracted to the spot most heated.

Many circumstances may cause one part of the cargo to be less permeable than the rest; should it prove so, the means readily offer for airing and purifying even this.

Suppose the hatches to be caulked down, and the hold made impervious to water; in such case, the lapse of air, under the obstructions met with in its passage, could by no means keep pace with the influx from the forcing-pump; consequently, if the holes in the deck, designed for its exit, be kept close-stopped till the pumper feels resistance, all the intervals of the cargo, be they ever so

Then, a single discharge of the forcing pump being eight gallons, five such discharges amount to 40 gallons, which is more than equal to the contents of 6 feet of four-inch pipe.

And as on the larger scale of ventilators the pipes need not exceed the same diameter, the power of the air injected, when its egress is stopt, will increase sufficiently to force its way through webs, mats, and other obstructions, though impervious to the atmospheric fluid, unassisted by such mechanic aid.

minute or irregular, must be occupied by fresh air, which, when permitted to escape, will carry off impurities with it. And thus, by stopping and opening such vents repeatedly, no part of the cargo could miss of purification, and this perhaps may be the best mode of administering it.

Prevention is better than a cure.

In a vessel equipped with the apparatus described, the inattention must be great, if the corn be suffered to sustain any injury at all. By an early use of it, perspiration and damps will presently be dried away; heating of course will be prevented; and even the production of the pernicious grub alluded to: for, be the nidus of its eggs ever so productive, their embryos will not vivify, without moisture to sustain them. Wherefore, it should seem that the corn-merchant in future will have little to fear, save the influx of sea-water; and even this (if in small quantities) will, by the frequent use of the ventilator, gradually dry away.

## No. 41.

*Directions for constructing a cheap Bed and elastic Frame, for the easy conveyance of sick or wounded Persons. Invented, and most humbly presented to his Royal Highness the Commander in Chief, By* PATRICK CRICHTON, *Lieutenant-colonel of the Second Regiment Royal Edinburgh Volunteers.*

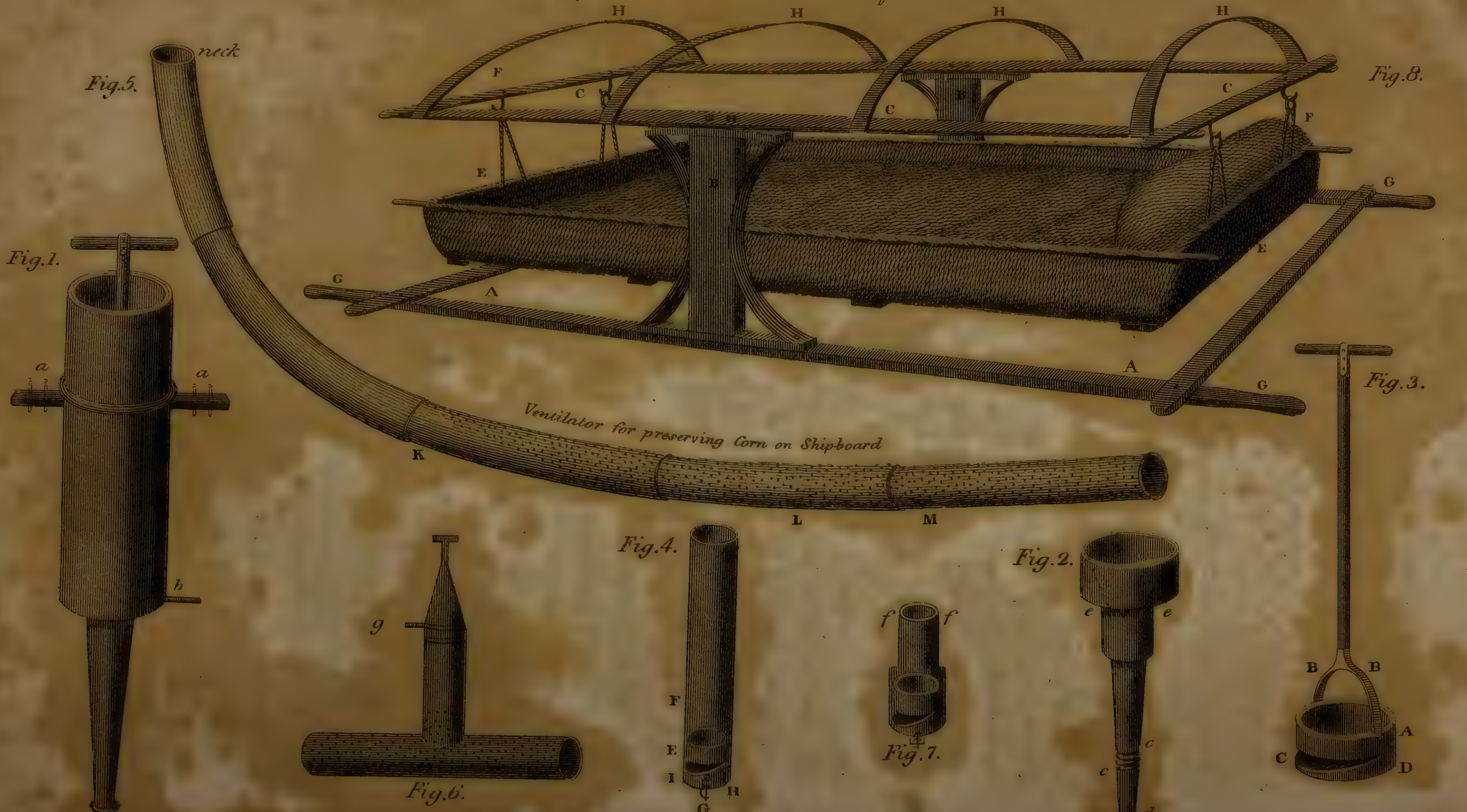
(With a Plate.)

### *Directions for the Construction of the Elastic Frame.*

REFERENCES.

THE lower frame A A (Plate 9, fig. 8,) is made of ash or elm, seven feet long, and five feet four inches broad.

Crichton's elastic frame & bed for conveying sick & wounded persons.






Tiebout Sc.

B B. Two strong wooden pillars, bound on the sides by two circular pieces of iron, for supporting the elastic frame.

C C C. The elastic frame, made of the best ash, supported by the wooden pillars, and semicircular pieces of iron.

E E. The frame or cott, containing a mattress or pelisse, stuffed with straw.—Two or three hammocks may be suspended, and will answer as well as the cott.

F F. Rings and iron hooks, by which the cott, bed, and mattress are supported.

G G G. Four handles projecting from the under frame, one foot three inches long each, by which the whole may be carried by four men.

H H H H. Four semicircular hoops, over which a cover can be thrown, to protect the patient from the weather.

The under frame and pillars should be made of ash or elm, well seasoned.

The elastic, or upper frame, should be made of ash, remarkably clean and well seasoned, thick in the middle where it is supported, and tapering towards the ends.

The total expense of the whole, including the ironwork, should not exceed four pounds ten shillings.

## *Directions for using the Bed and Frame.*

The lower frame may be fastened by ropes to any cart or waggon, of the same size, or larger than itself.

The sick or wounded person should first be placed in the bed. The frame should then be placed over the bed, and the ropes at the head of the bed suspended upon the iron hooks.

Then the ropes at the feet should be hooked up.

The frame, containing one or two sick men, can be easily lifted by the four handles by four men, and carried to any distance to a cart or baggage-waggon.

The lower frame is then fixed to the cart by ropes, and the machine is ready to move.

When the sick are taken from the baggage-cart, the whole frame should be lifted at once, and carried to the hospital.

The bed should then be unhooked, first at the feet and then at the head, and the frame taken away.

Upon large English waggons, two or three of these frames may be conveniently placed.

If the carts of any district are too small for the breadth of the frame, it may be made narrower, so as to adapt it to that conveyance.

---

When the machine, which is delineated in the plate, was first invented, it was solely intended for the use of the army.

To this purpose it has been successfully applied; and is in common application in several of the garrisons of Great Britain, as affording the easiest means of transporting sick or wounded soldiers, from garrison or quarters, to the hospital.

Since the time of its being adopted by the army, it has likewise been brought into the service of a great many of the public hospitals, not only for the purpose of conveying maimed or bedridden patients from their houses to the wards, but for removing such patients, as were under the necessity of undergoing operations, from the wards to the operation room, and returning them again from the operation room to the wards, without subjecting them to the necessity of being dressed, or even removed from the beds.

Having successfully answered these purposes, it has of late been used, when fixed upon a cart, waggon, or upon the carriage of a postchaise, for removing wounded

persons, or such as were afflicted with disease, and who were unable to support the motion of a chaise or coach, from different parts of the country to the towns where they might enjoy the benefit of medical advice.

In this manner, the use of it, in Scotland, has become of late very general, and, fortunately, very beneficial to those who have travelled in it; all of them concurring, that they were insensible of any unpleasant motion during their respective journeys.

To enumerate the instances of its successful application in this manner would fill a small volume; but a few facts will enable the public to appreciate its value.

A person was brought in it, with a compound fracture in the thigh bone, from the west Highlands to Edinburgh, a distance of 74 miles, in two days.

A gentleman, with an attack of gout both in his hands and feet, was removed from Edinburgh to the north of England, about 140 miles, in three days.

In both these instances, and a great many more, the bed and frame were suspended to the carriage of a post-chaise, and, with a servant sitting in front, travelled post.

Some hundreds of examples can be adduced of the removal of patients by its means, when fixed on a cart or waggon; and in many of these the patients were in a state of the most severe bodily distress and debility.

In all these removals, the patients have borne testimony to their enduring no additional pain or inconvenience from the motion of the machine; all of them, even in the most severe cases, declaring, that they were alike insensible of bodily fatigue, or of the least increase of pain, from the mode of conveyance.

The royal colleges of physicians and surgeons of this place have bestowed upon it the most unlimited approbation, both by letters addressed to the inventor, and in the publications of several of their members.

In consequence of these proofs of its successful effects, and these encomiums from the learned and respectable bodies who are so well enabled to decide regarding its merits, a number of applications have of late been addressed to the inventor, soliciting him to describe and delineate the machine, so as it might be introduced into general use in the various quarters of the kingdom.

To save time in complying with these requests, he adopted the method of printing and circulating these plates, accompanied with a description, which will clearly demonstrate, at how very small an expense, and with how very little mechanical art, the elastic frame can be constructed; for, in fact, there is no village in Britain, in which an ordinary smith and carpenter reside, where it may not be easily made.

Under these circumstances, the inventor feels it a duty he owes to his country, and to those suffering bodily distress, to give it all the publicity in his power; with which view, and with the most ardent wishes for its continuing to prove beneficial, in mitigating the distresses of such as may require its aid, this account is submitted to the public.

Gayfield Place,
17th Sept. 1807.

## *Indelible Ink.*

℞. Lunar Caustic, ʒi: weak solution of Galls, ʒ2. The cloth is to be first wetted with a solution of one ounce of salt of Tartar dissolved in ℥i ſs of water, and must be quite dry before using the ink.

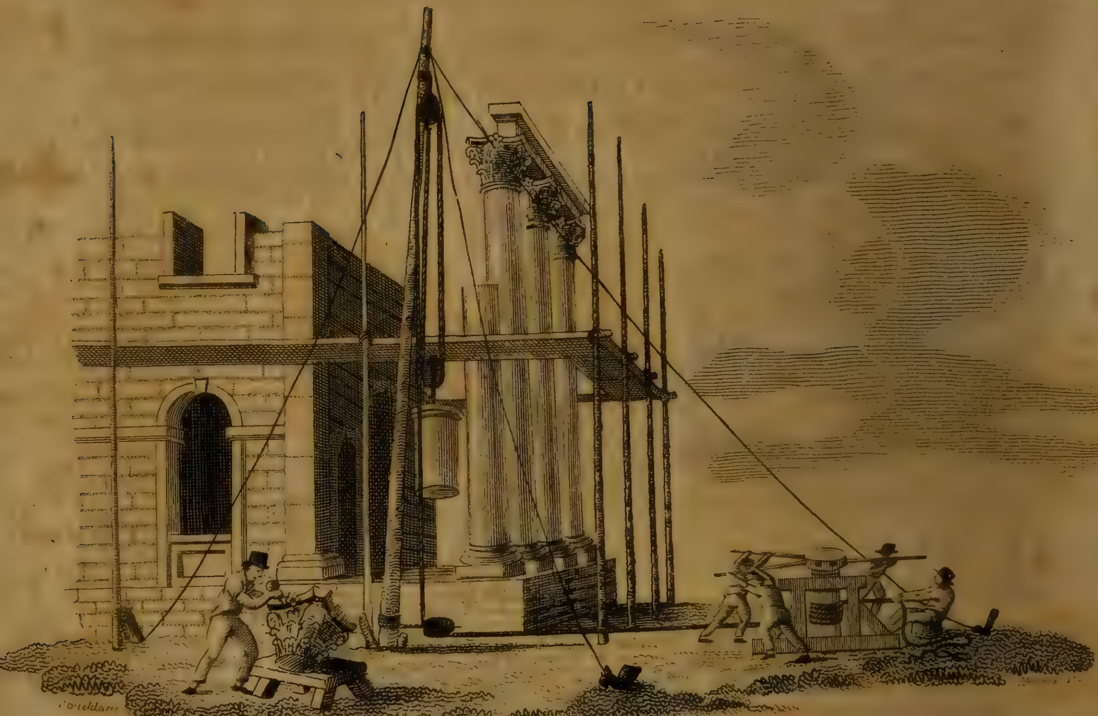
*Month. Mag. No.* 110.

ANOTHER.

Dissolve 4 drachms of Lunar Caustic in 4 oz. of rain or river water. To the clear solution add 60 drops of an infusion of 2 drachms of powdered galls in a gill of boiling water.

The cloth is to be previously wetted with a solution of 1 ounce of pearl ash in 4 oz. of water, and suffered to dry thoroughly.

*Philad. Med. Mus. Vol.* 1.



*Emporium of Arts & Sciences.*

THE

# EMPORIUM

OF

ARTS AND SCIENCES.

VOL. 1.] SEPTEMBER, 1812. [No. 5.

## No. 42.

## ON SPONTANEOUS COMBUSTION.

(Continued from page 253.)

*On the Spontaneous Ignition of Charcoal: by* B. G. SAGE, *Member of the Institute, Founder and Director of the first School of Mines.**

MR. de Caussigni appears to have been the first who observed, that charcoal was capable of being set on fire by the pressure of mill-stones.

Mr. Robin, commissary of the powder mills of Essonne, has given an account in the Annales de Chimie, No. 35, p. 93, of the spontaneous inflammation of charcoal from the black berry bearing alder, that took place the 23d of May, 1801, in the box of the bolter, into which it had been sifted. This charcoal, made two days before, had been ground in the mill without showing any signs of ignition. The coarse powder, that remained in the bolter, experienced no alteration. The light undulating flame, unextinguishable by water, that appeared

* Nicholson, vol. 23. p. 277. From Journal de Physique, vol. 65. p. 423.

on the surface of the sifted charcoal, was of the nature of inflammable gas, which is equally unextinguishable.*

The moisture of the atmosphere, of which fresh made charcoal is very greedy, appears to me to have concurred in the developement of the inflammable gas, and the combustion of the charcoal.

It has been observed, that charcoal powdered and laid in large heaps heats strongly.

Alder charcoal has been seen to take fire in the warehouses, in which it has been stored.

About thirty years ago I saw the roof of one of the low wings of the Mint set on fire by the spontaneous combustion of a large quantity of charcoal, that had been laid in the garrets.

Mr. Malet, commissary of gunpowder at Pontailler, near Dijon, has seen charcoal take fire under the pestle. He also found, that when pieces of saltpetre and brimstone were put into the charcoal mortar, the explosion took place between the fifth and sixth strokes of the pestle. The weight of the pestles is 80 pounds each, half of this belonging to the box of rounded bell metal, in which they terminate. The pestles are raised only one foot, and make 45 strokes in a minute.

In consequence of the precaution now taken, to pound the charcoal, brimstone, and saltpetre separately, no explosions take place; and time is gained in the fabrica-

* [Messrs. Aikins must, I presume, advert to the above fact, in the following quotation from their Chemical Dictionary, vol. 1. p. 238. although their reference is made to No. 36 of the An. de Chimie. Ed.]

" The affinity of charcoal for oxygen is so considerable, that instances have been known of its undergoing spontaneous combustion by simple contact with the air. An occurrence of this kind took place at the powder mills of Essonne in France. (An. de Chim. 36. p. 93.) A large quantity of recently burnt charcoal had been ground in the usual manner, and was deposited in a large receptacle for future use; some days after, the door of the magazine being opened in order to remove a part of the charcoal, an extraordinary heat was perceived, and immediately a train of fire was observed spreading over the surface of the charcoal, and which was not extinguished without much difficulty."

tion, since the paste is made in eight hours, that formerly required four and twenty.

Every wooden mortar contains twenty pounds of the mixture, to which two pounds of water are added gradually. The paste is first corned: it is then glazed, that is, the corns are rounded, by subjecting them to the rotatory motion of a barrel, through which an axis passes: and lastly, it is dried in the sun, or in a kind of stove.

Experience has shown, that brimstone is not essential to the preparation of gunpowder; but that which is made without it falls to powder in the air, and will not bear carriage. There is reason to believe, that the brimstone forms a coat on the surface of the powder, and prevents the charcoal from attracting the moisture of the air.

The goodness of the powder depends on the excellence of the charcoal; and there is but one mode of obtaining this in perfection, which is distillation in close vessels, as practised by the English.

The charcoal of our powder manufactories is at present prepared in pots, where the wood receives the immediate action of the air, which occasions the charcoal to undergo a particular alteration.

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## *Spontaneous Decomposition of a Fabric of Silk.**

On the night of March 19th, 1802, during the session of Congress at Washington, Jonathan Dayton, one of the senators then attending from the state of New-Jersey, sustained a loss of a pair of black silk stockings in an uncommon manner. On undressing himself at bedtime, his stockings were the last of his garments which he took off. The weather being cold, he wore two pair,

* Medical Repository, vol. 5. p. 458.

the inner of wool and the outer of silk. When he stripped off the silk stockings, he let them drop on a woollen carpet lying by the bed-side; and one of his garters, which was of white woollen ferretin, fell down with the stockings. The under-stockings, on being pulled off, were thrown at some distance, near the foot of the bed. He observed, on separating and removing the silk stockings from the woollen ones, that there was an unusual snapping and sparkling of electric matter. But as he had been long acquainted with the appearance, it attracted but transient notice.

He fell asleep, and remained undisturbed until morning, when the servant entered to kindle the fire. The man observed that one of the leather slippers, lying on the carpet, and partly covered by one of the stockings, was very much burnt. Mr. Dayton then rose, and found that the leather over which the stockings had lain was converted to a coal. The stockings were changed to a brown, or what is commonly called a butternut colour. And although, to the eye, the stitches of the legs, and even the threads of their clocks, appeared to be firm and entire, yet, as soon as an attempt was made to touch and handle them, they were found to be wholly destitute of cohesion, their texture and structure being altogether destroyed. Nothing but a remnant of carbonic matter was left, except that a part of the heel of one of the stockings was not decomposed.

Though this destruction of the stockings took place during the night, when nobody saw the manner and circumstances of the process, yet there was evidence enough of the evolution of much caloric while it was going on: for every thing in contact with the stockings was turned to coal or cinder. Beside the slipper before mentioned, the garter was burned. It had fallen partly on the carpet, and partly on and between the stockings. As far as

it touched the stockings it was perfectly disorganized and carbonated, and immediately beyond that limit was as sound as ever. The part of the carpet, with its fringe, which lay between the stockings and the floor, was in like manner totally destroyed, just as far as it was covered by the stockings, and no farther. The wooden plank, which was of pitch-pine, was also considerably scorched; and beneath the place where the thickest folds of the stockings had lain, was converted to charcoal or lamp-black to a considerable depth. In throwing down the stockings when they were pulled off, it happened that about a third part of the length of one of them fell not upon the carpet, but upon the bare floor. This part of the stocking was decomposed like the rest, and the floor very much scorched where it had lain.

There was very little fire on the hearth, and the little there was, was eight or nine feet distant. The candle had been carefully extinguished, and stood on a table in another direction, and about equally distant. Indeed, no application of burning coals or of lighted candles could have produced the effects which have been described. It would seem that the combustion, if it may be so called, proceeded from a surcharge of anticrouon (caloric), or electron (electricity), in the silk, accumulated by means not well understood; and that, not being referable to any known external agent, it may, in the present state of our information, be termed spontaneous.

The substances chiefly consumed were leather, wool, silk, and resinous wood. The linen lining of the slipper was indeed destroyed as far as the leather it touched was destroyed. But where it did not come in contact, it escaped, and the fire showed no disposition to burn even the linen beyond the boundaries prescribed to it on the leather.

What is the theory of this phenomenon? With what

other facts is it immediately connected? Whatever men of science may determine on these points, one thing seems to be evident, that if spontaneous combustion can happen thus to bodies so little inflammable as leather, silk, and wool, that instances of its occurrence in bodies easier to burn are more frequent than is generally supposed.

## *Ignition of a Carboy of Aquafortis.**

SIR—An extraordinary accident lately happened to my neighbour, Mr. Watts, chemist, in the Strand, which has excited the attention of several persons of his profession. I am anxious your ingenious readers should know some particulars respecting it; and if you will indulge me by inserting briefly an account of the affair, I shall feel obliged, as it might in future prevent a more serious evil.

Wr. Watts had taken into his premises, as usual, a carboy of aquafortis, and from some unknown cause, the following morning, his warehouse appeared to be on fire; there being a great quantity of smoke seen issuing from many parts of the building. On entering the apartment, the carboy was on fire, and more than half consumed. I saw the remains of the basket and straw taken into the yard. The air quickly revived the fire, and I have no doubt but I could very easily have blown it into a flame. Particular inquiry was made respecting the straw, and it appears to have been perfectly clean and new. There was no turpentine, or other inflammable spirits, within a foot of the spot where the carboy stood; and it has very much surprised all who have seen it, how the acid could ignite such materials without the aid of other agents. Perhaps some of your scientific cor-

* Tilloch, vol. 36. p. 234.

respondents can assign a cause for this strange event, which does not appear to be generally known, and may point out a remedy for preventing a more serious conflagration. I am, sir, your obliged humble servant,

R. Teed.

Lancaster Court, Strand,
11 September, 1810.

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## *Rapid Disorganization of the Human Body.**

On the night of the 16th of March, 1802, in one of the towns of the state of Massachusetts, the body of an elderly woman evaporated and disappeared from some internal and unknown cause, in the duration of about one hour and an half. Part of the family had gone to bed, and the rest were abroad. The old woman remained awake to take care of the house. By and by one of the grand-children came home, and discovered the floor near the hearth to be on fire. An alarm was made, a light brought, and means taken to extinguish it. While these things were doing, some singular appearances were observed on the hearth and the contiguous floor. There was a sort of greasy soot and ashes, with remains of a human body, and an unusual smell in the room. All the clothes were consumed; and the grandmother was missing. It was at first supposed she had, in attempting to light her pipe of tobacco, fallen into the fire, and been burned to death. But on considering how small the fire was, and that so total a consumption could scarcely have happened if there had been ten times as much, there is more reason to conclude that this is another case of that spontaneous decomposition of the human body, of which there are several instances on record. It is to be regretted the particulars have not been more carefully noted.

* Tilloch, vol. 14. p. 96.

### *A singular Ignition and Oxydation of Iron.**

Dr. Juch gives the following singular notice :—

"I had," says he, "a small leather flask filled with iron filings, which I frequently used with my electrophorus both charged and uncharged. I had occasion one day for a quantity of pure iron, and having no other at hand, had recourse to the filings in the flask, which I knew were pure. I emptied it on a piece of paper. I laid the paper on my hand in order to convey it to the place of its destination; but I had scarcely held it a few seconds when I perceived a strong heat, which increased so much that I could no longer hold the paper. Some minutes after, the paper became brown, and at length took fire. It did not, however, flame. The iron filings were in a state of ignition; and when the heat had decreased, I found the iron converted into a highly friable oxyd."

## No. 43.

### *Agenda; or a Collection of Observations and Researches the Results of which may serve as a Foundation for a Theory of the Earth. By* M. De Saussure.

(Continued from page 267.)

CHAP. XVIII.

### A. *Observations to be made on Volcanoes at the Time of an Eruption.*

1. The form, dimensions, and elevation of the crater.

2. The colour, elevation, and other sensible qualities of the flames and the smoke.

3. Phenomena which preceded the eruption, subterranean noise, earthquakes, extraordinary movements of the sea.

4. Phenomena which accompany the eruption; as

* Tilloch, vol. 5. p. 208.

thunder, lightning, positive or negative electricity, subterranean noise, earthquakes: scoriæ, ashes, and stones thrown up; to what height and distance.

5. Smell of the smoke. In general it indicates the sulphureous acid; but it may indicate also bitumen and coal.

6. Nature of the gases which escape during the eruption.

7. Velocity of the lava. Its degree of fluidity compared with the inclination of the ground over which it flows.

8. To measure, if possible, the degree of its heat when it issues from the volcano.

9. Whether the lava appears to be in a state of combustion, or only incandescence.

10. Whether it does not cool more slowly, and according to other laws, than that of the bodies heated or melted in our furnaces.

10. A. Can it be supposed that the matter thrown up by volcanoes was not inflamed, or even in a state of incandescence, in the bowels of the earth; and that it is only the contact of the air which gives it these qualities?

11. Whether the sudden cooling of lava in the air or in water divides it into prismatic columns, such as those of basaltes.

12. Whether it be true that scoria newly thrown up, and suddenly cooled by its rapid passage through the air, seems covered with a bituminous varnish.

13. And, in general, whether the mountain throws up bituminous matter or any thing that resembles the residuum of the combustion of coal, or whether it rather throws up pyrites or the residuum of their decomposition.

14. To ascertain by observations, and even by experiments, whether it may not be possible that pyrites or other ferruginous matters decomposed by water, undergo

a fermentation, which, acting on grand masses, may disengage a sufficient heat to produce the effects of a volcano.

15. Or whether, as M. Romme thinks, the fire of volcanoes is kept up by matters accumulated by rivers and currents of the sea.

16. To search for means of ascertaining the depth of the focus of the volcano.

17. To examine whether, at the moment when an eruption begins to take place, there is any remarkable change in the tides, currents, springs, and the nearest spiracles and volcanoes.

18. Muddy eruptions: their height, bulk, nature of the water they contain; whether it be saline: nature of the earth and stones thrown up; whether it contains sea shells, of what kinds, and in what state. Watery eruptions: the same researches: whether they hold in solution earths not usually soluble in water.*

### B. *Observations to be made at all Times on Volcanoes decidedly such.*

19. Nature of the countries and mountains between which they are found.

20. History of the volcano: its form, height, and extent in the most ancient times; its successive changes down to the present moment; its lateral mouths, and the epochs of their formation.

21. Chronology and enumeration of its different eruptions; description of them, and their most remarkable characters.

22. To descend, if possible, into the craters of extinguished volcanoes; to measure their depth; describe

* To observe those excavations from which considerable currents of air issue either periodically or constantly. Til.

their form, the nature of their sides, their strata, and the concretions adhering to them, such as sulphur, salt, &c.

22. A. To observe the *fumaroles*, or jets of smoke, often acid, which arise; their temperature, their nature, and their effects on the lava with which they come in contact.

23. To examine the fissures; whether they contain metallic or stony crystallisations, which may be considered as sublimed, and formed by the crystallisation of substances reduced to the state of smoke or vapour.

24. The nature of the streams of cooled lava; their extent and thickness.

25. Whether it be true that, in general, they are porous both at the upper and lower surfaces of the strata, and compact in the interior part.

26. To study the nature of the different currents placed above each other, in order to ascertain the difference that may have taken place in the focus of the volcano, and even in the source of its lava.

27. To examine, in general, in the lava, the nature of the earth and stones of which it has been formed.

27. A. To study the origin of the crystals found enclosed in the lava, as the white garnets or leucites in that of Vesuvius, in order to ascertain whether these crystals have been formed in the lava since the time of its fusion, or whether they pre-existed in the stones from which the lava was produced.

28. The nature and progress of the decomposition of the different kinds of lava, either by volcanic acids or meteors.

28. A. Whether there are any which have actually been in fusion, and yet have preserved all the external characters which the stone had before it was subjected to the action of the subterranean fires.

29. The origin of volcanic ashes, pozzolanas, tarras, tufas, &c.

30. The origin of pumice-stones: whether they are granites or feld-spars, asbestos, phrenites, deodalites, or potter's clay more or less ferruginous, or, lastly, the remains of the decomposition of pit-coal.

30. A. Whether, as M. de Fichtel believes, the action of the fire of volcanoes may augment the fusibility of feld-spar, and change it, in the same manner as quartz, into real zeolite.

31. Nature of the obsidians or volcanic glass: whether they be really glass, and the results of a complete fusion; or whether they are not rather stones of a vitreous appearance, and which have not been exposed to the action of a heat sufficiently strong to fuse them.

32. Whether there exist ancient kinds of lava, which, as related of those of Ischia, are susceptible of being heated by the moisture of rain and fogs, which would support the conjecture of No. 14.

C. *Observations to be made on Hills and Mountains which are doubted to have been really Volcanoes.*

33. The form, elevation, and other dimensions of the hill or mountain, the volcanic origin of which may appear doubtful.

34. Situation of its strata. To ascend to the summit of those which are inclined; to examine whether they have not a crater, or vestiges of one.

35. To observe, above all, whether, in departing from the most elevated point, there are found strata diverging in all parts, and proceeding from that point as a centre.

36. To study the characters of the stones which have been exposed to the action of the fire, in order to distinguish them from other porous stones, such as glandulous stones or amygdaloides.

37. When these characters are discovered, to examine whether, in the neighbourhood of the doubtful mountain, there are found scattered stones which exhibit the same characters, and which seem to have proceeded from that mountain.

38. To observe whether there are found, in the neighbourhood of the doubtful mountain, any vestige of the remains of heat concealed in the bosom of the earth, as of thermal, or even acidulous waters. It is well known that these signs are equivocal, but their combination with others may throw some weight into the scale.

38. A. Whether there exist certain proofs of alternate deposits of lava or other volcanic productions, and of matters accumulated or deposited by the sea.

39. Among the stones changed by the fire, to discover those which may be considered as having been subjected to the action of one stratum of coal in deflagration, and which the celebrated Werner calls *pseudo-volcanic,* and to distinguish them from those which have been fused in a real volcano.

40. Basaltes: their forms in columns, in beds, round masses; their connections, the relation which the basaltes of these different forms observe with each other.

41. The nature of these basaltes: that of their texture, of the points which they contain, of the pores and empty or full cells that may be observed in them; of their different accidents and decomposition.

41. A. The phenomena they exhibit in the fire, either exposed to, or sheltered from the action of the air. But before any arguments are drawn from these experiments, it will be necessary to resolve the question, Whether it be true that a stone may have been melted by subterranean fire, and yet none of its characters exhibit those indications of fusion which the fire of our furnaces would have given to the same stone.

42. Their connection, if there be any, with lava, fully ascertained as such: if it be true, for example, as M. Faujas affirms, that currents of lava are seen terminated by columns of basaltes.

43. The nature of the bases on which the basaltes rests: whether, as M. Werner says, any is found resting on wacke or hornstone, of an earthy and compact fracture, which itself reposes on sand or freestone.

44. Whether at other times basaltes is seen to repose on beds of coal (*houille*) which present no indications of combustion.

45. In a word, to examine whether the soil which bears them, or the sides of the veins in which they are contained, present indications of the action of fire, or at least of having been exposed to the contact of an incandescent mass; or, on the contrary, whether there appear indications of deposits of a substance which had been in a state of aqueous fluidity.

46. Whether there are in the basaltes vestiges of organised marine bodies or others; and in what state these vestiges are found.

47. Whether there are observed, as M. Faujas says, basaltes which seems to have formed a passage for itself from top to bottom through masses of granite.

48. In doubtful cases of this kind it would be necessary, were it possible to be at the expense, to push a gallery under a rock of basaltes, to examine whether the columns descend below the soil which seems to carry them; and if they are found below the soil, to sink a vertical well to ascertain the truth of the systems which suppose them to have been raised from the interior parts of the earth through the upper strata.

## CHAP. XIX.

### *Researches to be made in regard to Earthquakes.*

1. The historical part: the greatness, extent, and chronology of their ravages in different countries.

2. Does it appear that some countries are more exposed to them than others; are there some absolutely exempted; and how far is this connected with the local situation of the country?

3. To observe the extent, duration, and direction of the vibrations experienced by the earth when it shakes.

4. Are there any meteorological phenomena that announce or accompany earthquakes; such as extraordinary heat, calms, storms, movements of the barometer, electricity, vapours dispersed throughout the atmosphere, paleness or peculiar colour of the sun and stars?

5. Other phenomena; such as subterranean noise, extraordinary movement of the sea, the water of springs increased or dried up, any particular smell, symptoms of terror among domestic animals.

6. Are there any indications that some earthqakes may have been the effects of electricity, and that such convulsions might be prevented by conductors?

7. Are there not some also which immediately depend on subterranean fires, and which are preceded by or accompanied with volcanic eruptions?

8. Are there any which exhibit indications of the effects of water converted into steam?

9. To ascertain the simultaneous or at least astonishing rapidity of the effects of earthquakes at very great distances.

10. Are there any instances that, during the moment of an earthquake, some pretty considerable tract of land, or a mountain, has been raised to a great height above its

former level, and has afterwards remained in a state of elevation?

11. Are there dry fogs, such as that of 1783, which may be considered as vapours, that have issued from the earth by the action of shocks or concussions?

## CHAP. XX.

### *Observations to be made on Mines of Metal, Coal, and Salt.*

1. The historical part: the epoch of the discovery of a mine; of its being first worked; the expense and net produce at different periods. If there ever was, or still is, a grant of it, and on what conditions.

1. A. In regard to the physical part, care must be taken to examine whether the ore be in veins or strata; that is to say, whether it intersects the strata of the mountain, or be parallel to them.

2. In mines which consist of veins, the dimensions, thickness, and length of the veins are to be examined; their inclination in regard to the horizon, and their direction in regard to the cardinal points. The miners call this direction the *hours*.

3. The metal it contains; the mineralising substance, and the kind of mineral which thence results.

4. The matrix, or non-metallic fossil, found mixed with the ore.

5. The nature of the soil at the bottom, or that part of the mountain on which the vein rests; nature of the covering, or part of the mountain immediately above it.

6. Nature of the covering of the veins, or those parts of the vein next to the substance of the mountain.

7. Nature of the *druses*, or crystallised *geodes* contained in the vein.

7. A. The form, dimensions, and nature of the mountain which contains the vein.

8. Situation of the vein in regard to the strata of the mountain; under what angle it intersects them.

9. Its situation in regard to the exterior part of the mountain; whether it be parallel to the external inclination of the mountain, or whether that inclination be in a contrary direction.

10. The progress of the vein: whether it be subject to change its direction or situation, and according to what laws; if there are any indications that precede these changes; any corners, vacuities, or fissures, which interrupt the course of the vein; and how it is found after having been lost: situation and distance of the place where it is richest.

11. Lateral veins or ramifications of the principal vein; veins by which it is accompanied, or which run parallel to it.

12. To verify Werner's theory in regard to veins, the fundamental principles of which are as follows:—

A. That the spaces occupied by veins have been originally empty crevices or fissures.

B. That these fissures have been afterwards filled from the bottom upwards, at a time when the sea still covered the mountains; and by the precipitation or crystallisation of the substances which were before dissolved in the waters of the sea.

C. That of two veins crossing each other, the most modern is that which intersects the other.

D. That of two veins, one of which stops and diverts the course of the other, the most modern is the latter.

E. That, in the same vein, the parts nearest to the sides of the surrounding substance, the *salbande*, for instance, are the most ancient; those in the middle the most modern; and the intermediate ones of a mean antiquity.

F. Also that, in the same vein, the lowest parts are the most ancient.

G. That in some veins there are found rolled pebbles; in others the remains of organised bodies, shells, and wood; and in others, of coal, stones, and sea-salt.

H. That one may assign the relative age of the formation of different minerals; for example, that tin mines may be said to be of the most ancient formation; then those of uranite, bismuth, &c.

The greater part of the following questions will furnish confirmations of this theory, or objections against it, according to the solution given of them:

13. Is it true that there are mountains, or portions of mountains, so pierced with cotemporary veins that they could not have supported themselves, had not the substance with which they are filled been created at the same time as the mountain itself? I have used the expression cotemporary, because, if we can suppose that the fissures filled by these veins were formed in succession, the objection which this fact would present to the theory of Werner would be by these means resolved.

13. A. I must here repeat the 10th question of Chap. II. How can it be conceived that all the metals and substances found in a vein should have been dissolved by the water of the sea?*

14. Is it true that there are in Derbyshire vertical veins of lead intersected several times by horizontal strata of amygdaloides or loadstone?

15. Are there found, in the neighbourhood of veins, strata of the same mineral contained in these veins, and which seem to have been deposited at the same time when the deposits of the sea filled the fissures occupied by these veins?

* Or in the waters of the great ocean, which are supposed to have covered the whole globe of the earth. Til.

16. Is it well ascertained that there are certain metals and certain kinds of ore found only in certain kinds of mountains? And, if this circumstance be true, does it arise from the relative age of these minerals and mountains, or from the substance of the mountains favouring the precipitation of one kind of mineral more than that of another?

17. Is it true, as M. de Trebra says, that the richest veins, and the richest points of any vein, are found in the vertical line which corresponds with the lowest part of the reservoirs of the rain water, and never in the peaks and most elevated ridges? And, if this be well ascertained, would it not prove that the veins had an origin posterior to the grand revolutions which have given to the surface of our globe its present form, and that the metals have been deposited in them by the meteoric waters?

18. Is it true also that the richest mines are found in mountains, the declivities of which are not steep?*

19. Are there instances of veins, entirely exhausted, being again filled up with ore?

20. Does the production of metals depend on the influence of the sun and climate? Are they more frequently found near the eastern or southern, than the western or northern faces of mountains?

21. Can we generalise the observation made in Siberia, Transylvania, at Mount Rose, and in other places, that in gold mines the veins are richer near the surface of mountains than at a greater depth?

21. A. Is it generally true that the veins are richer at their points of intersection than in any other place?

22. Is the inclination of veins seen more frequently

* As the Saxon authors generally say; because the fact is true among them and in some other countries, while the case is not so elsewhere, and particularly in the Pyrenees. Til.

contrary, than parallel to, the adjacent face of the mountain?

23. Does it sometimes happen that the rock which forms the sides (*neben-gestein*) of the vein is as rich and even richer in metal than the vein itself; and would it thence follow, that the metal arrives at the vein by filtering itself through these sides?

24. Is it true that, in mountains of granite, the grain of the granite is finer and the stone more tender in the neighbourhood of a vein?

25. Are there observed in any mine proofs that subterranean fires have contributed to its formation by subliming the metallic substances, or by melting them? In a word, are there seen there any traces of the action of fire?

26. In the greater part of mines do we not, on the contrary, observe proofs of the action of water in the situation of minerals and of their matrices; in their *druses* (groups of crystals), and in the state, form, and nature of their crystallisation?

27. Does there prevail, at the bottom of mines, a heat superior to the mean temperature of the earth? And if such a heat exists in any mine, may it not be explained by that produced by the lamps; by the miners themselves; by some accumulations of pyrites, or some local reservoirs of water, without having recourse to a general cause or central fire?

28. Is it certain that, in general, veins decrease in thickness in proportion as they proceed to a greater depth, and terminate in such a manner that the fissures which contain them are closed at the bottom? Were this fact established, would it destroy the possibility of sublimations arising from the interior parts of the earth?*

* 28. A. Do there exist veins of from ten to twenty fathoms and more in thickness? or have not metalliferous banks or fissures between two different kinds of stone been taken for veins? Til.

29. In mines which proceed by strata, to observe their nature, extent, thickness, inclination, and depth; their interruption by the veins that intersect them; their alternate swellings and constrictions, as well as the augmentation and diminution of their richness, and the signs which precede these changes.

30. Whether it be rare to find, under the form of strata, other metallic mines than those of copper, iron, lead, calamine, and manganese.

31. Whether the mines in strata are generally poor near the surface of the mountain, and become richer the deeper they proceed.

31. A. Whether mines, where the metal is found in lumps or in a mass (*stockwerke*) ought to be classed among those in veins or those in strata?*

32. In coal mines to observe the nature of the coal; more or less compact; more or less rich in bitumen; more or less mixed with argil or pyrites.

33. To examine, in the coal, the traces of their origin; whether they have been formed of wood, turf, or marine plants.†

34. To observe whether there are found the remains of marine or terrestrial animals.

35. The progress of the strata: whether it be true that they often begin by descending in order to become horizontal, and afterwards to re-ascend; and that they

* 31. B. To observe also a third position of the ore, or ore found in the transitions (*stein-scheidung*); that is to say, between two kinds of stone of a very different nature; as between argillaceous schist and calcareous stone, between the same schist and compound rocks, &c. Not to confound this position of ore with real veins, nor with metalliferous banks, ore in strata, and the *stockwerke*. Til.

† 33. A. To distinguish carefully real coal from jet or fossil coal (the *braunkohle* of the Germans), and from coal earth, as well as from that substance known by the Germans under the name of *blend-kohle*. Til.

33. B. To examine whether there is not found sometimes in calcareous soil, fat, gelatinous coal; or whether there is never found but dry, friable coal. Til.

are thickest in the horizontal part, and give coal of a better quality.*

36. Whether there are several strata, one above the other, with banks or other fossils interposed. The quality and relation of these strata.

37. The nature and thickness of the strata of the earth or stones under which the coal mine is found; the impressions and other vestiges of organised bodies found in these strata.

37. A. How can those who ascribe the origin of coal to forests buried in the earth, explain the very thin strata of that fossil contained between banks of calcareous stones, and which are repeated at different heights in the same mountain? Does not this observation shew that there are coal which have originated also from fuci, algæ, and other marine plants?

37. B. Ought we to suppose that all coals have been in a state of solution? What is the agent which dissolved them, and which may be called the mineraliser?

38. Though mines of rock salt are commonly found in strata, yet M. Fichtel affirms, that there are found in Transylvania enormous masses of pure salt, compact, and without any appearance of foreign bodies. These he considers as of very ancient formation, and distinguishes them from those which are in strata between beds of argil and free-stone mixed with shells. These important facts deserve to be thoroughly examined.

39. To ascertain the truth of an assertion made by the same geologist, that these masses of salt are surrounded by ancient volcanoes; and to determine whether we ought to believe with him, that this salt has been crystallised by the heat of those volcanoes which evaporated the water that held them in solution.

* 35. A. To ascertain whether there exists fossil coal in veins, as is said to be the case at Wehrau in Upper Lusatia. Til.

40. To examine, in the last place, whether any of these masses of salt appear to have been raised up by subterranean fires to a height greater than that at which they were at the time of their formation.

41. To examine the reason of the singular connection observed between mines of salt or salt springs and mountains of gypsum.*

*(To be continued.)*

## No. 44.

## *A Treatise on the Cultivation of the Vine, and the Method of making Wines. By* C. Chaptal.

(Continued from page 277.)

### IV. *Of Fermentation.*

The must is scarcely put into the vat when it begins to ferment. That which flows from the grapes by the pressure or agitation they receive during the carriage, works and ferments before it arrives at the vat. This is a phænomenon which any one may easily observe by following the vintagers in warm climates, and carefully examining the must which issues from the grapes and remains mixed with them in the vessel used for carrying them.

The ancients carefully separated the first juice, which can arise only from the ripest grapes, and which flows naturally by the effect of the slightest pressure exercised on them. They caused it to ferment separately, and obtained from it a delicious beverage, which they called

* And particularly of gypsum coloured by a red argil. To examine also why asphaltes is commonly found in the neighbourhood of salt-pits.

42. To observe the different efflorescence of the different salts formed on the rocks and the surface of the earth, in order to determine their nature.

43. To observe also the nature, the abundance, and what may be discovered in regard to the origin of mineral waters: to determine the temperature of them. Til.

*protopon. Mustum sponte defluens, antequam calcentur uvæ.* Baccius has described a similar process practised by the Italians: *Qui primus liquor non calcatis uvis defluit, vinum efficit virgineum, non inquinatum fœcibus; lacrymam vocant Itali; cito potui idoneum fit et valde utile.* But this virgin liquor forms only one part of the juice which the grapes can furnish, and it cannot be treated separately, except when it is required to obtain wine very delicate and little coloured. In general, this first liquor is mixed with the rest of the grapes which have been trod, and the whole is left to ferment.

The vinous fermentation is always effected in vats of stone or of wood. Their capacity in general is proportioned to the quantity of the grapes collected from one vineyard. Those constructed of mason-work are for the most part of good cut stone, and the inside is often lined with bricks, joined together by a cement of pozzolano or strong clay. Wooden vats require more care to maintain them, are more subject to variations of temperature, and liable to more accidents.

Before the vintage is put into the vat, care must be taken to clean it. It must therefore be washed with warm water and well scrubbed, and the sides must be covered with two or three strata of lime. This covering is attended with this advantage, that it saturates a part of the malic acid, which exists abundantly in the must, as we shall show hereafter.

As the whole process of vinification takes place during the fermentation, since it is by it alone that the *must* passes to the state of *wine*, we think it necessary to consider this important subject under several points of view. We shall first speak of the causes which contribute to produce fermentation; we shall then examine its effects or its product, and shall conclude with deducing, from what we actually know on the subject, some general

principles which may direct the agriculturist in the art of managing it.

### *Of the Causes which have an Influence on Fermentation.*

It is well known that to establish fermentation, and make it follow all its periods in a regular manner, some conditions with which observation has made us acquainted are necessary. A certain degree of heat, the contact of the air, the existence of a sweet and saccharine principle in the must—such are nearly the conditions that are requisite; we shall endeavour to make known the effects produced by each of them.

### 1. *Influence of the Temperature of the Atmosphere on Fermentation.*

The 54th degree of Fahrenheit is pretty generally considered as the temperature most favourable to spiritous fermentation; below that degree it is languid; above, it becomes too tumultuous. At a temperature too cold or too hot, it does not take place at all. Plutarch observed that cold could prevent fermentation, and that the fermentation of must was always proportioned to the temperature of the atmosphere.* Bacon recommends the immersion of vessels containing wine, in the sea, to prevent its decomposition. Boyle relates, in his Treatise on Cold, that a Frenchman, to keep his wine in the state of must, and preserve to it that sweetness of which some persons are fond, closed the cask hermetically, and immersed it in a well or a river. In all these cases the liquor was not only kept in a temperature very unfavourable to fermentation, but it was secured from the contact of the air, which checks, or at least moderates, fermentation.

An extraordinary phenomenon, but which seems con-

* Quæst. Nat. 27.

firmed by a sufficient number of observations to merit full belief, is, *that fermentation is slower as the temperature has been colder at the time of collecting the grapes.* Rozier found in 1769, that grapes collected on the 7th, 8th, and 9th of October remained in the vat till the 19th without showing the least sign of fermentation: the thermometer in the morning had been at $3\frac{1}{4}$ degrees below freezing, and maintained itself at + 4. The fermentation was not completed till the 25th; while similar grapes collected on the 16th, at a temperature much less cold, terminated their fermentation on the 21st or 22d. The same thing was observed in 1740.

In consequence of these principles, it has been recommended to place the vats in covered places; to remove them from damp and cold places; to cover them, in order to moderate the cold of the atmosphere; to heat again the mass by introducing boiling must; and to make choice of a warm day for collecting the grapes, or to expose them to the sun, &c.

### 2. *Influence of the Air on Fermentation.*

We have seen in the preceding article that fermentation may be moderated and retarded by withdrawing the must from the direct action of the air, and keeping it exposed to a cool temperature. Some chemists, in consequence of these facts, are of opinion that fermentation can take place only by the action of the atmospheric air; but a more attentive observation of all the phenomena it presents in its different states, will enable us to set a just value on all the opinions which have been entertained on that subject.

The air, no doubt, is favourable to fermentation. This truth seems established by a concurrence of all the facts known; for, when preserved from the contact of the air, must will keep a long time without any change or altera-

tion. But it is proved also, that though must shut up in close vessels undergoes very slowly the phenomena of fermentation, it at length terminates, and that the wine produced by it is more generous. This is the result of the experiments of D. Gentil.

If a little yeast of beer and molasses, diluted in water, be introduced into a flask with a bent beak, and if the beak of the flask be opened under a bell filled with water, and inverted over a pneumatic tub, at the temperature of 60 or 65 degrees; according to my observations, the first phenomena of fermentation will always appear a few minutes after the apparatus has been thus arranged; the vacuum of the flask soon becomes filled with bubbles and foam; a great deal of carbonic acid passes under the bell; and this movement does not cease till the liquor has become spirituous. In no case have I ever seen an absorption of atmospheric air.

If, instead of giving free vent to the gaseous matters which escape by the process of fermentation, their disengagement be checked by keeping the fermenting mass in close vessels, the movement then slackens, and the fermentation terminates only with difficulty and after a very long time.

In all the experiments which I tried on fermentation, I have never seen that the air was absorbed. It neither enters into the product as a principle, nor into the decomposition as an element; it is expelled from the vessels with the carbonic acid, which is the first result of the fermentation.

Atmospheric air, then, is not necessary to fermentation; and if it appears useful to establish a free communication between the must and the atmosphere, it is because the gaseous substances which are formed in the fermentation may then escape, by mixing with or dissolving in the surrounding air. It follows also from this

principle, that when the must is put into close vessels the carbonic acid will find obstacles to its volatilisation: it will be forced to remain interposed in the liquid; it will be dissolved there in part, and, making a continual effort against the liquid, and each of the parts of which it is composed, it will slacken and extinguish almost completely, the act of fermentation.

That fermentation therefore may be established, and pass through all its periods in a speedy and regular manner, there must be a free communication between the fermenting mass and the atmospheric air. The principles which are then disengaged by the process of fermentation easily enter the atmosphere, which serves them as a vehicle, and the fermenting mass from that moment may, without any obstacle, experience movements of dilatation and expansion.

If wine fermented in close vessels is more generous and more agreeable to the taste, the reason is, that it has retained the aroma and the alcohol, which are in part lost in fermentation that takes place in the open air; for, besides their being dissipated by the heat, the carbonic acid carries them to a state of absolute solution, as we shall show hereafter.

The free contact of the atmospheric air accelerates fermentation, and occasions a great loss of principles in the alcohol and aroma; while, on the other hand, the withdrawing of that contact slackens the movement, threatens explosion and rupture, and the fermentation requires a long time to be complete. There are therefore advantages and disadvantages on both sides; but perhaps it might be possible to combine these two methods with so much success as to remove all their disadvantages. This, no doubt, would be the highest point of vinification. We shall see hereafter that some processes practised in different countries, either for making brisk wines, or

preserving to them a certain agreeable perfume, give us reason to hope for a more happy result of the labours that may be undertaken on this subject by persons of ability.

### 3. *Influence of the Volume of the fermenting Mass on Fermentation.*

Though the juice of the grape ferments in a very small mass, since I have made it pass through all its periods of decomposition in glasses placed on a table; it is nevertheless true, that the phenomena of fermentation are powerfully modified by difference of volumes.

In general, fermentation is the more rapid, speedier, more tumultuous, and more complete, as the mass is more considerable. I have seen the fermentation of must in a cask not terminated till the eleventh day; while a vat filled with the same liquor, and containing twelve times the volume of the cask, ended on the fourth day. The heat in the cask never exceeded 70 degrees; in the vat it rose to 88.

It is an incontestable principle, that the activity of fermentation is proportioned to the mass; but we must not thence conclude that it is always of advantage to carry on the process of fermentation in a large mass, or that the wine arising from fermentation established in the largest vats has superior qualities: there is a term for every thing, and there are extremes equally dangerous, which must be avoided. To have complete fermentation, care must be taken not to obtain it with too great precipitation. It is impossible to determine the volume most favourable to fermentation; it even appears that it ought to be varied according to the nature of the wine and the object proposed. If it be the preservation of the aroma, it ought to be performed with a smaller mass than when it is required to develope all the spirituous part to make wines proper for distillation. I have seen the thermome-

ter rise to 92 degrees in a vat containing thirty *muids* * of vintage Languedoc measure. In that case, indeed, all the saccharine principle is decomposed; but there is a loss of a portion of the alcohol by the heat and the rapid movement which the fermentation produces.

In general, the capacity of the vats ought to be varied according to the nature of the grapes. When they are very ripe, sweet, saccharine, and almost dry, the must has a thick consistence, &c. fermentation takes place with difficulty, and a great mass of liquid is required that the syrupy juice may be entirely decomposed; otherwise the wine remains thick, sweetish, and too luscious. It is only after being long kept in the cask that this liquor acquires that degree of perfection to which it is capable of attaining.

The temperature of the air, the state of the atmosphere, and the weather which prevails during the vintage—all these causes and their effects must be always present in the mind of the agriculturist, that he may be able to deduce from them rules proper for directing his conduct in regard to this object.

### 4. *Influence of the constituent Principles of Must on Fermentation.*

The sweet and saccharine principle, water, and tartar, are the three elements of the grape which seem to have a powerful influence on fermentation: it is not only to their existence that the first cause of this sublime operation is due, but it is to the very variable proportions of these different constituent principles that we must refer the principal differences exhibited by fermentation.

1st, It appears proved, by comparing the nature of all the substances which undergo spiritous fermentation,

* A *muid* contains 300 quarts, comprehending stalks, skins, and dregs. Tr.

that none are susceptible of it but those which contain a sweet and saccharine principle; and it is beyond a doubt that it is at the expense of this principle that alcohol is formed. By a consequence which naturally flows from this fundamental truth, bodies in which the saccharine principle is most abundant ought to furnish the most spiritous liquor. This is what is confirmed by experience. But it is impossible to insist too much on the necessity of making a careful distinction between *sugar* properly so called and the *sweet principle.* Sugar without doubt exists in grapes, and it is to it in particular that is owing the alcohol which results from its decomposition by fermentation; but this sugar is constantly mixed with a sweet body, more or less abundant, and very proper for fermentation: it is a real leaven, which almost every where accompanies sugar, but which by itself cannot produce alcohol. Hence it happens that, when it is necessary to ferment sugar in order to obtain rum, it is employed in the state of syrup called *vezou,* because it then contains the sweet principle which facilitates the fermentation.

The distinction between the sweet principle and sugar properly so called has been very well established by Deyeux in the *Journal des Pharmaciens.*

This sweet principle is almost inseparable from the principle of sugar in the products of vegetation; and these two principles are so well combined in some cases that they cannot be completely *disunited* but with difficulty. This is what will long prevent sugar, perhaps, from being extracted for commerce from several vegetables which contain it. The sugar-cane appears to be that of all the vegetables in which this separation is easiest. Many facts induce us to believe that this sweet principle approaches near in its nature to the saccharine principle; that, under favourable circumstances, it may

even be converted into sugar: but the present is not the moment for discussing this important point.

Grapes, then, may be very sweet and very agreeable to the taste, yet produce very bad wine: because sugar may exist only in very small quantity in grapes which to appearance are highly saccharine. This is the reason why grapes exceedingly sweet to the taste do not always furnish the most spiritous wines. In a word, a very little practice is sufficient to enable us to distinguish the really saccharine savour from the sweet taste which some grapes possess. Thus the mouth habituated to taste the highly saccharine grapes of the south, will not confound with them the *chasselas,* though very sweet, of Fontainebleau.

We ought therefore to consider sugar as the principle which gives rise to the formation of alcohol by its decomposition, and sweet and saccharine bodies as the real leaven of spiritous fermentation. That must, then, may be proper for undergoing a good fermentation, it ought to contain these two principles in proper proportions: sugar alone does not ferment, or at least the fermentation of it is slow and incomplete. Pure mucilage does not furnish alcohol; it is only to the union of these two substances that we are indebted for good spiritous fermentation.*

2d, Very aqueous must, as well as too thick must, experiences fermentation with difficulty. A proper degree of fluidity, then, is necessary to obtain good fermentation; and this is presented by the expressed juice of grapes which have come to perfect maturity.

When the must is very aqueous the fermentation is slow and difficult, and the wine arising from it is weak, and very susceptible of decomposition. In this case the

* There are some mucous bodies capable of undergoing spiritous fermentation; but it is probable that these mucous bodies contain sugar, which is more difficult to be extracted in proportion as the quantity is less.

ancients were accustomed to boil their must: by these means they caused the supernatant water to evaporate, and brought back the liquor to the proper degree of thickness. This process, always advantageous in the northern countries, and in general wherever the season has been rainy, is still practised. Maupin has even contributed to make this method be more adopted, in proving, by numerous experiments, that it may be used with advantage in almost all the wine countries. It however appears to be useless in warm climates; it is not applicable but in cases when the season having been rainy, has not permitted the grapes to attain to the proper degree of maturity, or when the vintage has taken place during wet or foggy weather.

There are some countries where baked plaster is mixed with the grapes to absorb the excess of humidity they may contain. The custom established in other places of drying the grapes before they are fermented is founded on the same principle. All these processes tend in an essential manner to remove the humidity with which the grapes may be impregnated, and to present a thicker juice to fermentation.

3d, The juice of ripe grapes contains tartar, which may be shown in it merely by concentrating the liquor, as we have observed: but verjuice furnishes a still greater quantity; and it is generally true that grapes give less tartar the more sugar they contain.

The marquis de Bouillon extracted from $2\frac{1}{8}$ wine pints of must about 10 dwts. of sugar and $1\frac{1}{2}$ dwt. of tartar. It appears from the experiments of the same chemist, that tartar as well as sugar concurs to facilitate the formation of alcohol. To obtain three times as much ardent spirit, nothing is necessary but to increase the proportion of the tartar and the sugar.

The same chemist has also proved that must deprived

of its tartar does not ferment, but that the property of fermenting may be restored to it by restoring to it that principle.

About 120 quarts of water, 100 ounces of sugar, and a pound and a half of cream of tartar, remained three months without fermenting. About 16 pounds of pounded vine-leaves were added, and the mixture fermented strongly for fifteen days. The same quantity of water and vine-leaves, left to ferment without sugar and without tartar, produced only an acidulous liquor.

In 500 quarts of cassonade and 10 pounds of cream of tartar fermentation was fully established, and continued forty-eight hours longer than in vats which contained simple must. The wine resulting from the first fermentation furnished one part and a half of brandy, at twenty degrees of Beaumé's areometer, in seven parts which had been distilled; while the wine made without the addition of sugar or tartar produced only a twelfth part of spirit at the same degree.

Saccharine grapes require, in particular, the addition of tartar: it is sufficient for this purpose to boil it in a kettle with the must, in order that it may be dissolved. But when must contains tartar in excess, it may be disposed to furnish ardent spirit by adding to it sugar.

It appears, then, from these experiments, that tartar facilitates fermentation, and concurs to render the decomposition of the sugar more complete.

### *Phenomena of the Products of Fermentation.*

Before we enter into a detail of the principal phenomena exhibited by fermentation, we think it proper to trace out briefly the progress it follows in its periods.

Fermentation first announces itself by small bubbles which appear on the surface of the must; by degrees some are seen to arise from the centre even of the mass

in a state of fermentation, and to burst at the surface; their passage through the strata of the liquid agitates all its principles, displaces all their moleculæ, and there soon results a hissing noise similar to that produced by a gentle ebullition.

Small drops, which immediately fall back, are then seen to rise several inches above the surface of the liquid. In that state the liquor is turbid, and every thing is mixed, confounded, agitated, &c.; filaments, pellicles, flakes, grapes, and stones, float separately, and are pushed, expelled, precipitated, and thrown up, till they at length settle at the surface, or are deposited at the bottom of the vessel. In this manner, and by a series of intestine movement, there is formed at the surface of the liquor a crust of greater or less thickness, called by the French *le chapeau de la vendange.*

This rapid movement and continual disengagement of these aëriform bubbles considerably increase the volume of the mass. The liquor rises in the vat above its primitive level. The bubbles, which experience some resistance to their volatilisation by the thickness and tenacity of the *chapeau*, force a passage to themselves in certain points, and produce abundant froth.

The heat increasing in proportion to the energy of the fermentation, an odour of spirit of wine is disengaged, and diffused every where around the vat; the liquor assumes a darker colour; and after several days, and sometimes even after a few hours, tumultuous fermentation, the symptoms decrease; the mass resumes its former volume, the liquor becomes bright, and the fermentation is almost terminated.

Among the most striking phenomena and the most sensible effects of fermentation, there are four principal ones which require particular attention; the production of

heat, the disengagement of gas, the formation of alcohol, and the coloration of the liquor.

I shall here speak of each of these phenomena, according to what we know of them with certainty from observation.

1st, *Production of Heat.*—It sometimes happens in cold countries, but particularly when the temperature is above 55 degrees, that the liquor put into the vat experiences no fermentation, unless some means can be found to heat the mass. This may be done by introducing into it warm must, stirring the liquor strongly, heating the atmosphere, or covering the vat with cloths.

But as soon as the fermentation begins, the heat acquires intensity. Sometimes a few hours' fermentation is sufficient to carry it to the highest degree. In general it is in the ratio of the swelling up of the mass; it increases and decreases like it, as will be proved by the experiments which I shall subjoin to this article.

The heat is not always equal throughout the whole mass; it is often more intense towards the middle, especially when the fermentation is not sufficiently tumultuous to mix and confound by violent movements all the parts of the mass: in that case the vintage is trod again; it is agitated from the circumference to the centre, and an equal temperature is established in every point.

We may admit as incontestable truths: 1st, That, at an equal temperature, the greater the mass of the vintage the greater will be the effervescence, movement, and heat. 2d, That the effervescence, the movement, and heat, are greater in vintage where the juice of the grapes is accompanied with the pellicles, stones, stalks, &c. than in must separated from all these matters. 3d, That fermentation can produce from 59 to 95 degrees of heat: at least, I have seen it in activity between these two extremes.

2d, *Disengagement of Gas.*—The carbonic acid gas disengaged from the vintage, and its effects hurtful to respiration, have been known since fermentation itself was known. This gas escapes in bubbles from every point of the vintage, rises in a mass, and bursts at the surface. It displaces the atmospheric air which rests on the vintage, occupies every where the vacant parts of the vat, and flows over the edges, precipitating itself in the lowest places on account of its gravity. It is to the formation of this gas, which takes a portion of oxygen and carbon from the constituent principles of the must, that we shall in future refer the changes which take place in fermentation.

This gas, retained in the liquor by all the means that can be opposed to its evaporation, contributes to preserve the aroma and a portion of alcohol which exhales along with it. The ancients were acquainted with these means, and they carefully distinguished the product of a *free* from that of a *close* fermentation; that is to say, the fermentation effected in open and that effected in close vessels. Brisk wines are indebted for that quality to their having been shut up in the bottles before their fermentation was completed. This gas, being slowly developed in the liquor, remains compressed in it till the moment when, the effort of the compression having ceased, by the opening of the vessels it can escape with force.

This acid gas gives to all liquors impregnated with it a tartish savour. Those mineral waters called *gaseous waters* are indebted to it for their principal virtue. But it would be having a very incorrect idea of its real state in wine, to compare its effects to those which it produces by its free solution in water.

The carbonic acid disengaged from wine holds in solution a pretty considerable portion of alcohol. I think I was the first who made known this fact, when I show-

ed, that by exposing pure water in vessels placed immediately above the *chapeau* of the vintage, at the end of two or three days this water is impregnated with carbonic acid, and that, to obtain very good vinegar, nothing is necessary but to put it into uncorked bottles, and to leave it to itself for a month. At the same time that the vinegar is formed, abundance of flakes, which are of a nature analagous to fibrous matter, are precipitated in the liquor. When water containing earthy sulphats, such as well-water, is employed instead of pure water, there is disengaged at the moment of acetification an odour of sulphurated hydrogen gas, which arises from the decomposition of the sulphuric acid itself. This experiment sufficiently proves that the carbonic acid gas carries with it alcohol and a little extractive matter; and that these two principles, necessary for the production of the acetous acid, being afterwards decomposed by the contact of the atmospheric air, produce acetous acid.

But is the alcohol dissolved in the gas, or is it volatilised merely by the heat? This question cannot be determined by direct experiments. Gentil observed in 1779, that when a glass bell was inverted over the vintage in fermentation, the inside of it became covered with drops of a liquid which had the smell and properties of the first phlegm that passes when spirits are distilled. Humboldt has proved that if the vapour of champagne be received under bells, in an apparatus for collecting gas, surrounded with ice, alcohol is precipitated on the sides merely by the impression of the cold. It appears, then, that the alcohol is dissolved in the carbonic acid gas, and it is this substance which communicates to the vinous gas a part of its properties. Every one feels, by the impression which the vapour of champagne makes on our organs, how this gaseous matter is modified, and differs from pure carbonic acid.

It is not the most saccharine must that furnishes the most gaseous acid, nor is it that employed in general for making the briskest wines. If the fermentation of this kind of grapes were checked by shutting them up in casks or jars to preserve the gas disengaged from them, the saccharine principle, which abounds in them, would not be decomposed, and the wine would be sweet, luscious, thick, and disagreeable. There are some wines all the alcohol of which is dissolved in the gaseous principle: that of Champagne furnishes a proof of it.

It is difficult to obtain wine red and brisk at the same time; especially as, to make it acquire colour, it must be suffered to ferment over the skins, stalks, &c.; and as by these means the acid gas is dissipated.

There are some wines the slow fermentation of which continues for several months. These, if put into bottles at the proper time, become brisk: there are none, strictly speaking, but wines of this kind capable of acquiring that property. Those the fermentation of which is naturally tumultuous terminate this process too soon, and would break the vessels in which they are enclosed.

This acid gas is dangerous to be respired. All animals exposed to it are suffocated. Such melancholy accidents are much to be apprehended when the vintage is made to ferment in low places where the air is not renewed. This gaseous fluid displaces the atmospheric air, and at last fills the whole cellar. It is the more dangerous as it is invisible like air; and too much precaution cannot be taken against its fatal effects. To ascertain whether there be any danger, those who enter a place where vintage is in a state of fermentation ought to cause a lighted candle to be carried before them: if the candle continues burning, there is no danger; but if it is seen to grow dim, and then to go out, it will be prudent to retire.

This danger may be prevented by saturating the gas

in proportion as it is precipitated on the floor, by scattering in several places milk of lime, or quicklime. A place rendered noxious by this pernicious gas may be purified by throwing upon the floor and against the walls quicklime diluted in water: a caustic alkaline ley, such as soapmakers' ley or ammonia, will produce a similar effect. In all cases the gaseous acid instantly combines with these matters, and the external air descends to occupy its place.

3d, *Formation of Alcohol.*—The saccharine principle exists in must, and makes one of its principal characters: it disappears by fermentation, and is replaced by alcohol; which essentially characterises wine.

We shall mention hereafter in what manner this phenomenon, or this interesting series of decompositions and productions, may be conceived. Our business at present is to indicate the principal facts which accompany the formation of alcohol.

As the object and effect of spiritous fermentation are merely the production of alcohol by decomposing the saccharine principle, it thence follows that the formation of the one is always in proportion to the destruction of the other, and that the alcohol will be more abundant as the saccharine principle is greater: for this reason, the quantity of alcohol may be augmented at pleasure by adding to the must the sugar which seems to be wanting.

It invariably follows from these principles, that the nature of the vintage in fermentation is every moment modified and changed: its smell, taste, and other characters, are continually varying. But as there is a very constant progress in the process of fermentation, it may be followed in all its changes, which may be considered as invariable signs of the different states through which the vintage passes.

1st, Must has a sweetish odour, which is peculiar to

it. 2d, Its savour is more or less saccharine. 3d, It is thick, and its consistence varies according as the grapes are more or less ripe, more or less saccharine. I have found by experience that some marked 75 degrees of the areometer, and others only from 40 to 42. It is exceedingly soluble in water. Scarcely is the fermentation determined when all the characters are changed: the odour begins to become pungent by the disengagement of carbonic acid; the savour, still very sweet, is however already mixed with a little of the pungent; the consistence decreases; the liquor, which hitherto presented only one uniform whole, exhibits flakes which become more and more insoluble.

The saccharine savour becomes gradually weaker, and the vinous stronger: the consistence of the liquor is sensibly lessened: the flakes detached from the mass are more completely insulated. The odour of the alcohol is perceived at a greater distance.

At last the moment arrives when the saccharine principle is no longer sensible; the savour and smell now indicate nothing but alcohol: all the saccharine principle, however, is not destroyed; a portion of it still remains; the existence of which is not masked by that of the predominant alcohol, as is confirmed by the very correct experiments of Gentil. The further decomposition of this substance takes place by the aid of the tranquil fermentation which is continued in the casks.

When the fermentation has passed through, and terminated all its periods, no more sugar exists; the liquor has acquired fluidity, and presents only alcohol mixed with a little extract and colouring principle.

4th, *Coloration of the vinous Liquor.*—The must which flows from the grapes transported from the vineyard to the vat before they have been trod, ferments

alone, produces *virgin wine*, the *protopon* of the ancients, which is not coloured.

Red grapes, the juice of which is expressed by mere treading, always furnish white wine when not fermented with the skins, stalks, &c.

Wine becomes more and more coloured as the vintage remains longer without being fermented. Wine is less coloured as the grapes have been less trod, as greater care has been taken to cause them to ferment in the skins, &c.

Wine is more coloured as the grapes are riper and less aqueous.

The liquor furnished by the skins, &c. when subjected to the press is less coloured.

The southern wines, and, in general, those made from grapes collected in places well exposed to the south, are more coloured than the wines of the north.

Such are the practical axioms which have been sanctioned by long experience. Two fundamental truths thence result: the first is, that the colouring principle of wine exists in the skins of the grapes; the second is, that this principle does not detach itself, and is not completely dissolved in the vintage but when the alcohol is developed in it.

We shall treat in the proper place of this colouring principle, and shall show, that though it approaches resins in some of its properties, it is, however, essentially different.

Any one, after this short explanation, may account for all the processes usual for obtaining wines more or less coloured; and may readily conceive that it is in the power of the agriculturist to give to his wines whatever tint of colour he chooses.

*(To be continued.)*

## No. 45.

## *Method of obviating the Necessity of lifting Ships. By Mr.* Robert Seppings, *of Chatham Yard.**

The following is a description of an invention by Mr. Robert Seppings, late master shipwright assistant in his majesty's yard at Plymouth (now master shipwright at his majesty's yard, Chatham), for suspending, instead of lifting, ships, for the purpose of clearing them from their blocks, by which a very great saving will accrue to the public, and also two-thirds of the time formerly used in this operation.

From the saving of time another very important advantage is derived, namely, that of enabling large ships to be docked, suspended, and undocked, the same spring tides. Without enumerating the inconveniencies arising, and, perhaps, injuries, which ships are liable to sustain, from the former practice of lifting them, and which are removed by the present plan; that which relates to manual labour deserves particular attention; twenty men being sufficient to suspend a first-rate, whereas it would require upwards of 500 to lift her. The situation which Mr. Seppings held in Plymouth-yard, attached to him, in a great degree, the shoring and lifting of ships, as well as the other practical part of the profession of a shipwright. Here he had an opportunity of observing, and indeed it was a subject of general regret, how much time, expense, and labour, were required in lifting a ship, particularly ships of the line. This induced him to consider whether some contrivance could not be adopted to obviate these evils. And it occurred to him, that if he

* Tilloch, vol. 22. p. 242. From the Transactions of the Society of Arts, who voted him the gold medal, 1804.

could so construct the blocks on which the ship rests, that the weight of the ship might be applied to assist in the operation, he could accomplish this very desirable end. In September, 1800, the shoring and lifting the San Josef, a large Spanish first-rate, then in dock at Plymouth, was committed to his directions; to perform which, the assistance of the principal part of the artificers of the yard was requisite. In conducting this business, the plan, which will be hereafter described, occurred to his mind; and from that time, he, by various experiments, proved his theory to be correct: the blocks, constructed by him, upon which the ship rests, being so contrived, that the facility in removing them, is proportionate to the quantity of pressure; and this circumstance is always absolutely under command, by increasing or diminishing the angle of three wedges, which constitute one of the blocks; two of which are horizontal, and one vertical. By enlarging the angle of the horizontal wedges, the vertical wedge becomes of consequence more acute; and its power may be so increased, that it shall have a great tendency to displace the horizontal wedges, as was proved by a model, which accompanied the statement to the society; where the power of the screw is used as a substitute for the pressure of the ship.

Mr. Seppings caused three blocks to be made of hard wood agreeable to his invention, and the wedges of various angles. The horizontal wedges of the first block were nine degrees; of the second, seven; and of the third, five; of course, the angle of the vertical wedge of the first block was 162 degrees; of the second, 166; and of the third, 170. These blocks, or wedges, were well executed, and rubbed over with soft soap for the purpose of experiment. They were then placed in a dock, in his majesty's yard, at Plymouth, in which a sloop of war was to be docked: on examining them af-

ter the vessel was in, and the water gone, they were all found to have kept their situations, as placed before the ship rested upon them. Shores in their wake were then erected to sustain the ship, prior to the said blocks being taken from under the keel. The process of clearing them was, by applying the power of battering-rams to the sides of the outer ends of the horizontal wedges; alternate blows being given fore and aft; by which means they immediately receded, and the vertical wedges were disengaged. It was observed, even in this small ship, that the block which was formed of horizontal wedges of nine degrees, came away much easier than those of seven, and the one of seven than that of five. In removing the aforesaid blocks by the power of the battering-rams, which were suspended in the hands of the men employed, by their holding ropes passed through holes for that purpose, it was remarked by Mr. Seppings, that the operation was laborious to the people; they having to support the weight of the battering-rams, as well as to set them in motion. He then conceived an idea of affixing wheels near the extremity of that part of the rams which strikes the wedges. This was done before the blocks were again placed; and it has since been found fully to answer the purpose intended, particularly in returning the horizontal wedges to their original situations, when the work is performed for which they were displaced; the wheels also giving a great increase of power to the rams, and decrease of labour to the artificers; besides which, the blows are given with much more exactness. The same blocks were again laid in another dock, in which a two-decked ship of the line was docked. On examination they were found to be very severely pressed, but were removed with great ease. They were again placed in another dock in which a three-decked ship of the line was docked. This ship having in her foremast

and bowsprit, the blocks were put quite forward, that being the part which presses them with the greatest force. As soon as the water was out of the dock, it was observed that the horizontal wedges of nine and seven degrees had receded some feet from their original situations. This afforded Mr. Seppings a satisfactory proof, which experience has since demonstrated (though many persons before would not admit of, and others could not understand, the principle), that the facility of removing the blocks or wedges, was proportionate to the quantity of pressure upon them. The block of five degrees kept its place, but was immediately cleared, by applying the power of the battering-rams to the sides of the outer ends of the horizontal wedges. The above experiments being communicated to the Navy Board, Mr. Seppings was directed to attend them, and explain the principle of his invention; which explanation, further corroborated by the testimonials of his then superior officers, was so satisfactory, that a dock was ordered to be fitted at Plymouth under his immediate directions. The horizontal wedges in this, and in the other docks, that were afterwards fitted by him, are of cast iron, with an angle of about five degrees and a half, which, from repeated trials, are found equal to any pressure, having in no instance receded, and, when required, were easily removed. The vertical wedge is of wood, lined with a plate of wrought iron, half an inch thick. On the bottom of the dock, in the wake of each block, is a plate of iron of three quarters of an inch thick, so that iron at all times acts in contact with iron.

The placing the sustaining shores, the form and sizes of the wedges, and battering rams, &c.; also the process of taking away, and again replacing, the wedges of which the block is composed, are also exemplified by a model.

The dock being prepared at Plymouth, in August,

1801, the Canopus, a large French 80-gun ship, was taken in, and rested upon the blocks; and the complete success of the experiment was such, that other docks were ordered to be fitted at Sheerness and Portsmouth dock-yards, under Mr. Sepping's directions. At the former place a frigate, and at the latter a three-decked ship, were suspended in like manner. This happened in December, 1802, and January, 1803; and the reports were so favourable, as to cause directions to be given for the general adoption of these blocks in his majesty's yards. This invention being thought of national consequence, with respect to ships, but particularly those of the navy, government has been pleased to notice and reward Mr. Seppings for it.

The time required to disengage each block is from one to three minutes after the shores are placed: and a first-rate sits on about fifty blocks. Various are the causes for which a ship may be required to be cleared from her blocks, viz. to shift the main keel; to add additional false keel; to repair defects; to caulk the garboard seams, scarples of the keel, &c. Imperfections in the false keel, which are so very injurious to the cables, can, in the largest ship, be remedied in a few hours by this invention, without adding an additional shore, by taking away blocks forward, amid-ships, and abaft, at the same time; and, when the keel is repaired in the wake of those blocks, by returning them into their places, and then by taking out the next, and so on in succession. The blocks can be replaced in their original situations, by the application of the wheel battering-rams to the wedges, the power of which is so very great, that the weight of the ship can be taken from the shores that were placed to sustain her. There were one hundred and six ships of different classes, lifted at Plymouth dock-yard, from the 1st of January, 1798, to the 31st of December, 1800;

and, had the operation of lifting taken less time, the number would have been considerably increased; for the saving of a day is very frequently the cause of saving a spring tide, which makes the difference of a fortnight. The importance of this expedition, in time of war, cannot be sufficiently estimated.

This invention may be applied with great advantage, whenever it is necessary to erect shores, to support any great weights, as, for instance, to prop up a building during the repair of its foundation, &c. Captain Wells, of his majesty's ship Glory, of 98 guns, used wedges of Mr. Sepping's invention for a fid of a top-gallant mast of that ship. In 1803, the top-gallant masts of the Defence, of 74 guns, were fitted on this principle by Mr. Seppings: and, from repeated trials, since she has been cruizing in the North Sea, the wedge fids have been found in every respect to answer.

But it is Mr. Sepping's wish that it should be understood, that the idea of applying this invention to the fid of a top-gallant mast originated with captain Wells, who well understood the principle, and had received from him a model of the invention.

When it is required to strike a top-gallant mast, the top ropes are hove tight, and the pin which keeps the horizontal wedges in their place is taken out, by one man going aloft for that purpose; the other horizontal wedge is worked in the fid, as shown in the drawing and model that accompany this statement. The upper part of the fid hole is cut to form the vertical wedge. The advantage derived from fidding top-gallant masts in this way is, that they can be struck at the shortest notice, and without slacking the rigging, which is frequently the cause of springing and carrying them away, particularly those with long pole heads. The angle of the horizontal wedges for the fids of masts should be about twenty degrees.

The above account was accompanied with certificates from sir John Henslow, surveyor of the navy; Mr. M· Didram, master-shipwright of Portsmouth-yard; and Mr. John Carpenter, foreman of Sheerness dock-yard, confirming Mr. Sepping's statement.

*Reference to the Engraving of Mr. Sepping's method of obviating the necessity of lifting ships.* Plate 10.

This plan and section of a seventy-four gun ship describes the method of obviating the necessity of lifting ships, when there may be occasion to put additional false keels to them, or to make good the imperfections of those already on; also, when it may be necessary, to caulk the garboard seams, scarples, the keel, &c.; by which means a very considerable part of the expense will be saved, and much time gained. The blocks are cleared, and again returned by the following process. A sufficient number of shores are placed under the ship to sustain her weight, and set taught, stationed as near the keel as the working of the battering-rams fore and aft will admit. Avoid placing any opposite the blocks, as they would in that case hinder the return of the wedges with the battering-rams. A blow must then be given forward on the outer end of the iron wedges with the battering-rams in a fore and aft direction, which will cause them to slide aft, as shown in the plan. The battering-rams abaft then return the blow, and the wedges again come forward; by the repetition of this operation, the wedges will be with great ease cleared, and the angular block on the top will drop down. When the work is performed, the block must be replaced under the keel, and the wedges driven back by working the rams athwart-ships, as described in the section.

N. B. In returning the iron wedges, to avoid straining the angular blocks, it is proposed to leave a few of

them out forward and aft, and stop the ship up, by laying one iron wedge on the other, as shown at Fig. 1, Plate 10.

To facilitate the business, blocks may be cleared forward and aft at the same time, sufficient to get in place one length of false keel. If the false keel should want repairing, it may be done without any additional shores, by clearing one block at a time; and when the keel is repaired in the wake of that block, return the wedges, as above directed, and clear the next, &c.

*Section and Plan*, Plate 10, Fig. 2.

A, Keelson.

B, Ceiling.

C, Floor timber.

D, Dead or rising wood.

E, Plank of the bottom.

F, Keel and false keel.

G, Angular blocks with a half-inch iron-plate bolted to them.

H, Cast-iron wedges.

I, Iron-plate of three-fourths of an inch thick on the bottom of the dock.

K, Battering-rams, with wheels, and ropes for the hands.

L, Cast-iron wedges, having received a blow from forward.

M, Shores under the ship to sustain her weight.

*Fig.* 3, represents part of a top-gallant mast fitted with a wedge fid.

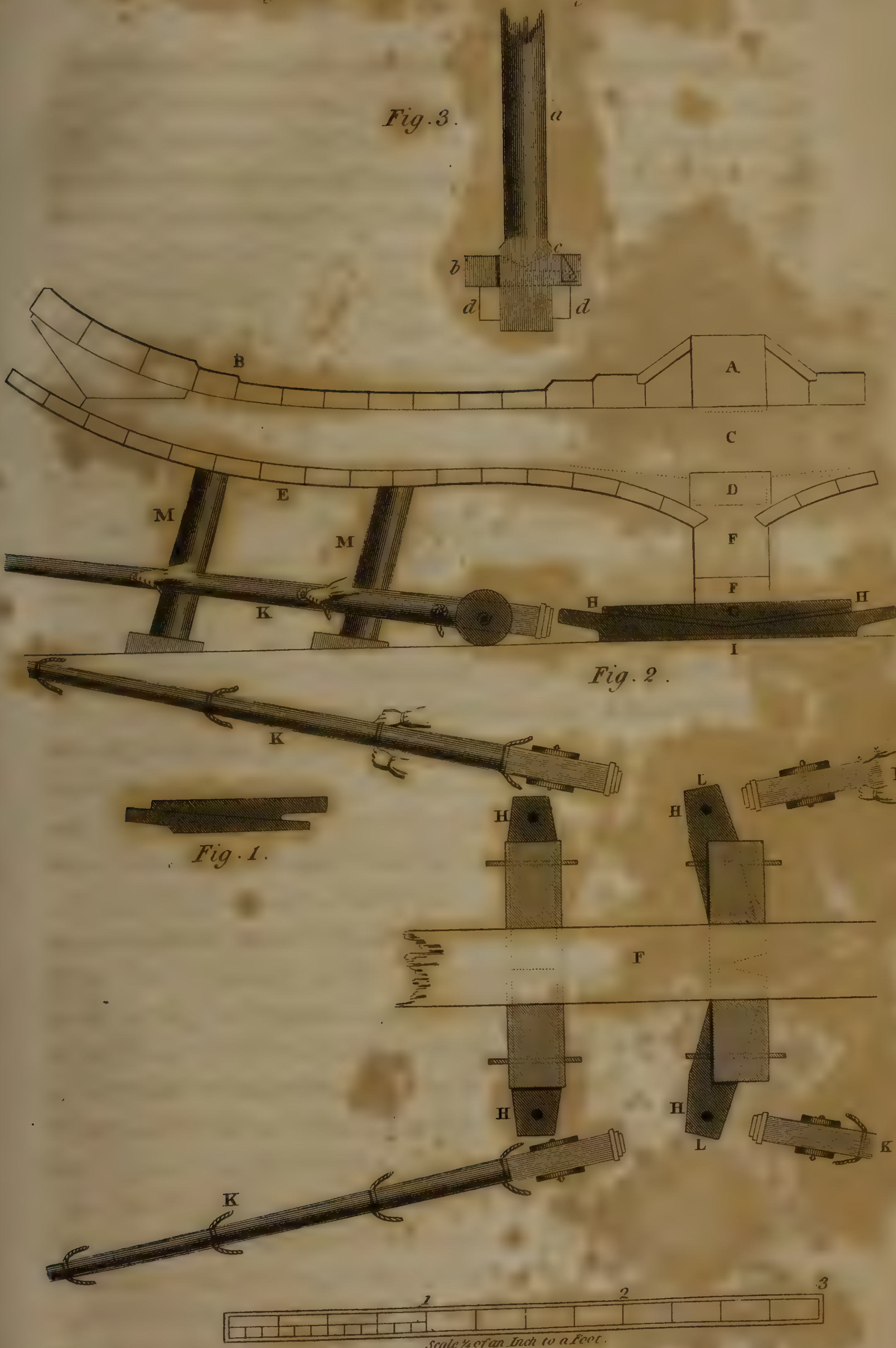
*a*, Top-gallant mast.

*b*, Fid, with one horizontal wedge worked on it.

*c*, Moveable wedge, with the iron strap and pin over it, to keep it in its situation.

*d*, Trussel trees.

Mr. Seppings Method of suspending Ships.






Tiebout.

## No. 46.

*On the irregularity in the rate of going of Time-pieces occasioned by the influence of Magnetism. An original Communication, by Mr.* Varley, *dated May* 31, 1798.*

Having studied the theory of clock and watch-making many years, as well as been, part of that time, concerned in an extensive manufactory of watches, I have had many opportunities of observing a circumstance which has surprised every one in the trade as well as myself; that watches of considerable price, and from the hands of excellent workmen, often perform no better than a plain one of inferior workmanship and much lower price. Being anxious, as may naturally be supposed, to furnish my friends with watches or clocks which would go well, I made it my business to pay particular attention to whatever could contribute to their perfection. With this view, I made almost numberless experiments and observations on the various escapements now in use, the different constructions of balances, pendulums, pendulum springs and compensations, both for clocks and watches, which have been applied by very ingenious mechanics and excellent workmen to correct the errors in the rate of going, especially of watches, occasioned by the various degrees of heat and cold, change of position, external agitation, influence of oil, friction, variation of maintaining power, and other causes.

Some of these contrivances are extremely well adapted to answer the intended purpose; but, notwithstanding all their advantages, the maker and purchaser are frequently disappointed in the performance of the machine to which they are applied. Many instances might be

* Tilloch, vol. 1. p. 16.

produced where the best workmen have been employed, no expense spared by the maker, and the above-mentioned improvements applied with the utmost care and attention; and yet the rate of going of the watch has been more irregular than in some ordinary watches. When such a circumstance occurs, it is extremely unpleasant: the purchaser not understanding the difficulties which the maker has to encounter, thinks himself ill used, and the latter suffers at the same time in his reputation as an artist, and in his character as a man; and when the watches happen to have been made for nautical purposes, or for exportation, the whole community, in some measure, become sufferers.

The intention of the present paper is to point out a defect in the construction of time-pieces of every description in which balances are used, and at the same time a source of error in their performance, which has been hitherto little if at all suspected, but which, where it occurs, completely defeats all the ends intended to be answered by the application of the above-mentioned ingenious contrivances: and that it does occur very frequently, will be made sufficiently obvious by a simple detail of facts supported by actual experiments.

That the balances of watches, when manufactured of steel, as they mostly are, might be in a small degree magnetic, and consequently have some influence in disturbing their vibrations, has been suspected by some and denied by others: but that a circular body, such as a balance is, should possess polarity; that a particular point in it should have so strong a tendency to the north, and an opposite point an equal tendency to the south, as to be sufficient materially to alter the rate of going of the machine when put in different positions, has never, I believe, been even suspected. If it had, the use of steel balances would have been laid aside long ago, particularly where

accurate performance was indispensible, as in time-pieces for astronomical and nautical purposes. Though I have frequently examined, with great care, watches that did not perform well, even when no defect in their construction or finishing was apparent, and suspected the balance to be magnetic, yet I never could have imagined that this influence, operating as a cause, could produce so great an effect as I found upon actual experiment; for I did not expect to find that a balance, even when magnetic, should have distinct poles. Happening to have a watch in my possession, of excellent workmanship, but which performed the most irregularly of any watch I had ever seen, and having repeatedly examined every part with particular attention, without being able to discover any cause likely to produce such an effect, it put me upon examining whether the balance might not be magnetic enough to produce the irregularity observed in its rate of going.

I took the balance out of its situation in the watch, and, after removing the pendulum spring, put it into a poising tool, intending to approach it with a magnet, but at a considerable distance, to observe the effect, while at the same time the distance of the magnet should preclude the possibility of the magnetic virtue being thereby communicated to the balance. I had no sooner put it into the tool than I observed it much out of poise; that is, the one side appeared to be heavier than the other: but, as it had been before examined, in that particular, by a very careful workman, more than once, I was at a loss to determine what to think of the effect I saw; when happening to change the position of the tool upon the board, the balance then appeared to be in poise. As there could be no magic in the case, it appeared that the balance had magnetic polarity, as no other cause could produce the effect I had witnessed, and which was repeated as often

as I chose to move the tool from the one position to the other. It happened that I was then sitting with my face to the south: a circumstance that led me, in placing the plane of the balance vertically, to put it north and south, and of course the axis east and west—the only position in which the magnetic influence could make itself most apparent, and which will account for the circumstance not having been observed by the workman who examined the poise of the balance before I did; for, as often as I placed the plane of the balance vertically between east and west it was in poise, whichever end of its axis was placed towards the south.

Having pretty well satisfied myself as to the cause, I now proceeded to determine the poles of the balance. With that view I placed its axis in a vertical situation, and of course its plane was horizontal; and I was much surprised to find that, in that position, it possessed sufficient polarity to overcome the friction upon its pivot; for it readily turned on its axis to place its north pole towards the north. Making a mark on that side that I might know its north pole, I then repeatedly turned that point towards the south; and, when left at liberty, it as often resumed its former position, performing a few vibrations before it quite settled itself in its situation and came to rest—exactly as a needle would do if suspended in the same manner.

I was extremely happy that I had observed these effects before I brought a magnet to make the experiment I first intended, as I might, and as others also might have concluded, that the polarity had been produced by the approach of the magnet. I now, however, brought a magnet into the shop, and, presenting its south pole to the marked side, that is, to the north pole of the balance, the balance continued at rest; but upon presenting the north pole to the marked place, it immediately receded

from the magnet, and resumed its former position whenever the magnet was withdrawn.

No doubt now remaining as to the facts, and being in possession of the position of its poles, I proceeded to examine the effects produced by this cause upon the watch's rate of going. Having put on the pendulum spring, and replaced the balance in the watch, I laid the watch with the dial upwards, that is, with the plane of the balance horizontally, and in such a position that the balance when at its place of rest should have its marked side towards the north:—in this situation it gained 5′ 35″ in twenty-four hours. I then changed its position so that the marked side of the balance when at rest should be towards the south, and, observing its rate of going for the next twenty-four hours, found it had lost 6′ 48″—producing, by its change of position only, a difference of 12′ 23″ in its rate. It must be obvious to every person, that even this difference, great as it was, would be increased or diminished as the wearer should happen to carry in his waistcoat pocket a key, a knife, or other article made of steel. This circumstance, taken along with the amount of the variation occasioned by the polarity of the balance, was fully sufficient to produce all the irregularity observed in the going of the watch.

I then took away the steel balance, substituted one made of gold, and, having brought the watch to time, observed its rate of going, and found it as uniform as any watch of the like construction; for, though it was a duplex escapement, which is perhaps the best yet invented, at least for common purposes, it had no compensation for the expansion and contraction occasioned by heat and cold, and therefore a perfect performance was not expected.

Steel balances being commonly in use, and, on that account, easiest to be procured, and being on many ac-

counts preferable to any other, I was unwilling to abandon them entirely; but resolved to take the precaution of always trying them before I should apply them to use. The mode I adopted was, to lay them upon a slice of cork sufficient to make them float upon water, and I was in hopes that out of a considerable number I might be able to select sufficient for my purpose; but to my surprise, out of many dozens which I tried in this manner, I could not select one that had not polarity. Some of them had it but in a weak degree, and not more than one or two, out of the whole quantity, appeared to have it so strong as the one which gave birth to these experiments and to the present paper, which is perhaps more prolix than could be wished: but the subject appeared to be not uninteresting, and I hope the remarks I have offered will not be altogether useless, as every thing that can tend to add to the perfection of time-pieces, or to remove any cause that operates against their perfection, is of some importance.—&c. &c.

S. VARLEY.

## No. 47.

### *Description of a Camp Telegraph, invented by* KNIGHT SPENCER, *Esq. Secretary to the Surry Institution.**

SIR—The important advantages resulting to the naval service from the introduction of the telegraph by sir Home Popham, now universally adopted, are too well known to be here insisted upon.

That telegraphic signals have been productive of great advantages to land armies, for more than 3000 years, is very easily proved.

* Tilloch, vol. 36. p. 321.

That *the most important advantages have resulted* to the French arms, from the use of the telegraph, in the present age, is too well authenticated to be doubted.

That commanders of British armies have felt the absolute necessity of adopting some mode of telegraphic communication, is proved by the late campaign in Sicily, and the present campaign in Spain.

That many attempts have been made to introduce the telegraph into our land-service universally, cannot be questioned.

To what cause, then, is it to be attributed, that to the present moment this powerful instrument remains to British armies (generally speaking) nearly a useless invention?

The only *rational* answer to this question seems to be, that, hitherto, no practicable system has been offered, and the attempts to introduce it must, probably, have failed;—either, from the intricacy of the machines, or, the difficulty of transporting them into situations where they could be used.

Whatever cause may have hitherto retarded its introduction, it will hardly for a moment be contended, that, were a telegraph produced as certain in its operations as the present fixed telegraph, and at the same time so simple and portable as to require no separate establishment, either for its transport or management, it would not be a most important acquisition in the field.

With this conviction on my mind, I have endeavoured to obviate the supposed difficulties; and the result, which I call my CAMP TELEGRAPH, I request permission to lay before the public through the medium of your respectable Magazine;—indulging the hope, that it may meet the attention of those who have sufficient influence to bring the subject fairly under the consideration of his majesty's government. Perhaps it may not be improper

to state, that my invention has already been honoured with the approbation of several general and other officers very capable of forming correct opinions on the subject;—and that I have frequently asked a question with it at the distance of *six miles,* and have received an answer within *three minutes.* Any officer of ordinary capacity will be able, after two hours' application, to direct a station; any private will perform the duty of a signal-man after half an hour's drill; and, the apparatus not being more cumbrous than a serjeant's pike, there seems no necessity whatever for a separate establishment to manage it.

### *Explanation.*

To work the Camp Telegraph, which is *numerical,* the director of each station must be assisted by three privates or others, to be called signal-men; one of whom must be furnished with a staff 13 or 14 feet high, on which must be mounted two flexible balls, about three feet diameter, as described below:—this is called the *centre-point.* The other two signal-men must each be furnished with a staff ten feet high, mounted with one flexible ball.

The signals must be made by one or both of the signal-men taking an ordered number of paces to the right or left of the centre-point; in the rear of which the director takes his stand, during the time of making communications.

All signals must be made by order of the director of the station, who must give the word for the necessary number of paces. These are to be taken by the signal-men, in *double-quick time,* carrying their balls at the trail; and when they have arrived at the point or points ordered, the balls must be instantly elevated.

All signals must be repeated by the corresponding sta-

tion; and when the director of the station making the communication, observes this is done, he gives the word "*Down*," and his signal-men must then retire in double-quick time to the rear of the centre-point, carrying their balls at the trail. The word "*Down*" must likewise be given by the director of the station *receiving a communication*, the instant he observes the signal-men at the corresponding station begin to retire.

A. (Plate 11.) Is the signal of *communication*, and is made by placing one of the signal-men at 20 paces to the right, and the other at 20 paces to the left, of the centre-point.

B. Is the signal of a *point or period*, and is to be made at the close of a number, as 275, by placing one signal-man three paces to the right, and the other three paces to the left, of the centre-point.

C. Is the signal of *error*, and is to be made when your correspondent has mistaken your last signal:—Suppose you had made the signal No. 2, which is 20 paces to the right, and your correspondent answers with 20 paces to the left, which is the signal No. 7. Then make the signal of error, by placing one signal-man three paces to the left, and the other 10 paces to the right of the centre-point; and when your correspondent has repeated this signal, thereby convincing you he is sensible of his error, *repeat the signal that had been mistaken*, and, if rightly answered, proceed as before.

D. Is the *repeating* signal, and is to be made if the last communication is not understood. It is made by placing one signal-man three paces, and the other 20 paces, to the left.

### *Numerals.*

No. 1. Is made by placing one signal-man three paces to the right of the centre-point.

No. 2. By placing one signal-man 20 paces to the right.

3. By placing one signal-man 10 paces, and one 20 paces, to the right.

4. By placing one signal-man at three, and one at five paces, to the right.

5. By placing one signal-man at 18, and one at 20, paces to the right.

6. By placing one signal-man three paces to the *left* of the centre-point.

7. By placing one signal-man 20 paces to the left.

8. By placing one signal-man 10, and one 20, paces to the left.

9. By placing one signal-man at three, and one at five, paces to the left.

0. By placing one signal-man at 18, and one at 20, paces to the left.

The flexible ball is constructed in the following manner:

Take an ash or deal staff of the required length, and the substance of a stout pike. Take twelve whalebones, four feet six inches long, and fix them at nine inches from the top of the staff, in the way the whalebones of umbrellas are fixed:—fix the lower ends of these whalebones to a strong slide (like the slide of an umbrella), the pipe of which must be 18 inches long, and project upwards. To the top of this pipe, stretchers 18 inches long must be affixed, and also to the middle of each whalebone, like the stretchers of an umbrella, to keep the ball stiff when in use. There must then be a strong umbrella-spring fixed on the staff, at three feet from the upper fastenings of the whale-bones, or top of the ball, so that, when the slide is pushed up, the whale-bones will form a sphere of three feet diameter.

The skeleton of the ball being thus prepared, it is to be covered with glazed linen, half black and half white, divided *vertically*. Letter G is a drawing of the skeleton of the ball, but only showing two whalebones instead of twelve. When the balls are not in use, they will be unsprung, and covered with strong cloth cases.

### *Signals by Night.*

To make these, it will require two lamps, about nine inches square and 12 inches high, to be elevated, one above the other, at the distance of three or four feet, for the centre-point: and one lamp for each signal-man, to be fixed on the top of the ball-staff.

Each lamp must have two hollow lenses, about four inches diameter, filled with different-coloured transparent fluids—(say pale green and pale red),—which will distinguish them from common lights. They must be suspended upon a pin, put through a strong iron frame, resembling the frame of a sign which is fixed upon an upright sign-post, so that when the staff is raised they will swing perpendicularly; and when they are carried at the trail, they will still be in a perpendicular position.

The reservoir for the oil must be made like those for the agitable lamps; the wicks must be flat, and about one inch broad.

E. is a front view of the lamp for night signals.

F. is a side view of the same.

A code of numerical signals, and a numerical vocabulary applicable to the land service, arranged upon the plan of Sir Home Popham's for the naval service, will be necessary.

When a tent or any other object is fixed upon as a centre-point, it is then generally unnecessary to use the double ball.

When stations are taken *below the horizon,* the white

sides of the balls are to be turned to your correspondent, and it is advantageous to have the men in white or fatigue dresses.

When stations are taken *above* the horizon, the black sides are to be turned towards your correspondent, and then it is advantageous to have the men in uniform.

I am, sir, your obedient servant,

KNIGHT SPENCER.

Surry Institution,
Nov. 6, 1810.

## No. 48.

### *Invention of a Homograph, or Method of Communication by Signals, on Sea or Land. By* LIEUTENANT JAMES SPRATT, *of the Royal Navy.**

SIR—With this you will receive a truly ingenious invention of Lieut. James Spratt, of the Royal Navy. This gallant officer, in the glorious action of the combined fleet at Trafalgar, on the 21st of October, 1805, was on board his majesty's ship Defiance. When engaged within pistol shot with a French eighty-gun ship called l'Aigle, he plunged into the sea, swam to the enemy's stern, and entered the gun-room port alone, made his way courageously through the different decks, and succeeded in mounting the enemy's poop, where placing his hat on the point of his cutlass, he called out to his men to join him. In attempting to haul down the French colours, he was attacked by several of their grenadiers, whom he repulsed with success. He was soon followed by several of our jolly tars, and in the act of saving the life of a French officer who cried out for quarter, a musket was

* Nicholson, vol. 25. p. 325. Transact. of the Society of Arts, vol. xxvii. p. 163. The silver medal was voted to Lieut. Spratt for this invention.

levelled by a Frenchman at his own breast, which he fortunately struck downwards, but his leg was fractured by the shot; he afterwards fought two of the enemy on his knees, who were quickly dispatched by his companions, and the French ship soon after struck. More particulars of this transaction are recorded in the XV volume of the Naval Chronicle, page 193. I have the pleasure to add, that Lieut. Spratt, after a tedious illness, has recovered the use of his leg, and now has the command at the signal post at Teignmouth, anxiously wishing to be again employed in more active service against the enemies of his country.

I have taken the liberty of sending this communication, and the account of his invention, unknown to him, knowing that the Society of Arts &c. is generally disposed to encourage merit in every rank and situation wherever found. M. S.

This new, easy, and useful code of signals is to be performed with a white pocket-handkerchief, to be held in different positions with the body. Plate 11, fig. 1, A, with the dotted lines, exhibits the whole of the numeral homograph signals at one view, (see the positions that the handkerchief is held in, and the figures marked). The first position from the right foot to the right hand is No. 1, the others No. 2, 3, 4, 5, 6, 7, 8, 9, and 0, follow in succession. When making 1, 5, 9, and 0, the handkerchief should be held by the diagonal corners, as generally prepared for wearing round the neck.

For making 2, 3, 4, 6, 7, 8, the opposite sides of the handkerchief should be gathered in each hand, the near extremity of the handkerchief to be held by one hand to the point of the shoulder.

In working the homograph the body should be erect, the positions steady, the handkerchief to be held well in

front of the arms, and facing the person to whom you are to impart your intentions.

The best place for showing signals from a ship is in the chains, or on a lower deck port, as the white handkerchief exhibits a greater contrast with the black sides, and is of course better discerned. When on shore, they should be made from the side of a green hill, or in front of some thick foliage, or hedge, or dark wall.

The positions intended to compose the number of signals should be made in succession. The person, to whom a signal is made, should wave his handkerchief horizontally, to convince you that it is understood.

When the positions which compose the number of your signals are finished, you are to wave your handkerchief in like manner. For example, persons who make use of the homograph should arrange in their separate books, or from a telegraphic dictionary, every question and answer, which may occur to them on any subject, as there is no limitation to the numbers. If the number affixed to your communication be 1000, you are first to make position No. 1, and keep it so until your consort answers it by waving his handkerchief, which informs you that it is understood; then you are to make the 0 three times distinctly, as shown at figure A, each 0 to be kept up until answered as before. Now your signal being made, wave your handkerchief, which informs your consort, that he is to refer to his book for the purport of the signal No. 1000, which may either refer to a distinct word in dictionaries numbered alike, or to a whole senctence in conversations, premeditated and inserted in books formed for the purpose.

When you wish to commence a communication by signals, you are to display the handkerchief in the manner shown at fig. B, which is called the signal of attention, and your consort is to display his in return. The per-


Emporium of Arts & Sciences Vol. 1. pl. II.

son who displays first has a right to begin the communication, and to prevent confusion, it is to be displayed at the commencement of every signal.

If by any accident your attention should be called off, and you did not comprehend the whole of a signal, by holding the handkerchief as in fig. C, you may demand a repetition. This signal is called the repeat. Fig. D, shows the following signals, by twisting the handkerchief regularly round one of the arms, and holding it in one of the positions marked 1, 2, 3, 4, viz. No. 1, affirmative; No. 2, negative; No. 3, interrogative; No. 4, to annul.

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Sir—I acknowledge the receipt of your letter respecting my homograph, and beg leave to express the high sense I entertain of its having been noticed by so distinguished an institution as that of the Society of Arts, &c. I am positively the first inventor of it, and I put it in execution at the commencement of this war, on board his majesty's ship Defiance, commanded by P. C. Durham, who did me the honour to express his approbation of it, and promised to bring it to the notice of his royal highness the duke of York; but having the honour of getting a fractured leg in the battle of Trafalgar, I was prevented from getting attention to my homograph.

I have frequently conversed in this manner with my messmates at Spithead, from the green ramparts at Portsmouth, and from Plymouth Sound to the Hoe, which is still a greater distance. The conversation may be carried on at the distance of four miles by a common telescope.

The various uses to which the homograph may be applied at any moment, without expense, will not fail to attract the notice of persons of discernment. In active military service it will be found very important. It will be

found useful to naval captains lodging on shore, who may thus communicate any orders with ease and accuracy to the commanding officers of their ships at anchor. Passengers on board ships in fleets may keep up a constant and friendly intercourse, to console themselves for the tediousness of a long voyage; and the country gentleman may, at a moment's warning, summon his neighbours to the sports of the field, or to the hospitable board.

If my homograph should meet with the approbation of the Society of Arts, &c. and tend to the good of the community at large, I shall be highly gratified.

I have the honour to be, &c.

James Spratt.

Teignmouth Signal-Post,
Dec. 26th, 1808.

The following Certificates were received from Lieut. Glanville, R. N.; Lieut. Tayler, R. N.; Mrs. Spratt, of Burlington-House; and Miss Taylers, daughters of the mayor of Devizes.

I do hereby certify, that being at Ryde in the Isle of Wight in the summer of the year 1806, I frequently conversed with Lieut. Spratt, by means of the homograph invented by him; and previous to the battle of Trafalgar, Lieut. Spratt conversed in this way with many officers at Gibraltar. I also certify, that I have heard from officers of the Brest, Cadiz, and Mediterranean fleets, that Lieut. Spratt was the inventor, and the first person who made use of such invention. Given under my hand this 10th day of Jan. 1809.

J. N. Tayler,
Lieut. of his majesty's ship Spencer.

We the undersigned do hereby certify, that being at Ryde in the Isle of Wight in the summer of the year

1806, we did frequently see Lieut. Spratt of the Royal Navy conversing from the shore, by means of the homograph invented by him, with Lieut. J. N. Tayler, then on board his majesty's ship the Leopard, lying at Spithead. Ann Tayler further saith, that she with many others saw it used with great success at Teignmouth.

Witness our hands, Feb. 2d, 1809.

MARY TAYLER,
ANN TAYLER,
MARGARET SPRATT. } Devizes, Wilts.

This is to certify, that I, George Glanville, Lieut. of the Royal Navy, saw Lieut. Spratt, then master's mate of the Defiance, conversing by means of a homograph from the ship Defiance, with Lieut. Nicholas on board the Malta, six or eight months previous to the Trafalgar action, and that they seemed perfectly to understand each other by the signals given.

Witness my hand this 30th day of May, 1809,

GEORGE GLANVILLE, Lieut. R. N.

## No. 49.

### *Improvement of Nooth's Apparatus; in a letter from Dr. Wilkins of Baltimore, dated August* 12, 1812.

(With a Plate.)*

DEAR SIR—The use of artificial Mineral Waters having become very general in our large cities, both as a medicine and luxury, the inhabitants of smaller places, and the country, seem very desirous of having a method of preparing them. The costliness of the large apparatus

* The plate will be given in the next number.

used here, is a barrier to their general use; and the waters drawn off into jugs soon become flat and insipid, with every precaution. Nooth's apparatus, which is very elegant, has been laid aside on account of the great danger of breaking it: almost every one introduced into use, has soon met with its fate, under the greatest precautions. In nineteen cases out of twenty the machine has been broken by the air being obstructed in the valve, which is both complex and difficult; of course a contrivance that would give a free discharge to any quantity of air, that might be emitted from the ingredients, would at once remove the great cause of damage, as well as simplify the operation. I herewith communicate to you a plan, that I think simple and effectual, which may re-introduce that machine, and if with this, the precaution be used to keep the vitriolic acid ready diluted for use, and a small guard-board be made over the superior stopper, that it may play, but not spring out, there will then remain no danger but what is common to all glass; and it will be as rare to hear of one being broke, as it is now to hear of one being sound. A great number of those imported are at first defective in the valve, which will never be the case in this way; and of course can be sold at a lower price. For better understanding the plan, I send you a drawing, though I will first describe the apparatus and method of fixing it.—A silver or glass siphon, not less than one eighth of an inch in the bore, making a contracted arch so as to occupy little more room than a double tube, is made to pass through the bottom of the middle part of the machine, and there fix the extremity of its longest leg, thus communicating (when set up) with the lowest part; then passing up beyond the highest water mark (an inch or more) it returns quite down to the apex of the same piece of the machine, and discharges the air at the bottom of the water. A little

nozle may be fitted on with many apertures in it (as in a water pot) to divide the stream of air; or a small piece of gause or silk of very loose texture may be tied on in form of a globular bag at the end. Such a piece will be necessary even over the nozle, tied at a small distance in advance: for when water is forced into the superior part of the machine, as is frequently the case, it stands above the arch of the * siphon, and if at that time the pressure from below relaxes by the absorption or escape of air and the cessation of discharge, the pressure from above would be liable to force some of the water through the siphon into the lower part of the machine; this will be prevented by the little bag before mentioned, pressing into the tube, or applying itself over the holes in the nozle, but would never, if properly put on, and sufficiently open, obstruct the air coming out, as it would then be distended. It would be advisable to have about two inches of the long end of the siphon separate, and cemented into the lower part or place of the old valve, as a receptacle, and fitted there, that the rest might be removed and cleaned (if silver), and if the siphon is made of glass, it would be best to have a silver receptacle. Many old machines with bad valves or none, may be repaired by passing the long leg of such a siphon through a cork, and fixing it in the old aperture for the valve: some might prefer this method in new machines, and have a glass stopper at that part to receive the siphon (as shewn in the plate.) This would be more costly and liable to accident, though somewhat easier to introduce the siphon. In the other plan it must be introduced above, with a pair of forceps. Water may be impregnated in a much shorter

* This elevation of water will often return, if the upper stopper is very tight, and the bent tube attached to the upper part of the machine is so long as to enter the main body of water. It would therefore be as well to have it something shorter, in new made machines.

time than in the old way, by the air passing so freely, as it does through the siphon.

Fig. 1, Pl. 12. View of Nooth's Apparatus, with the siphon valve—the syphon rising above the water mark.

Fig. 2. *a*, Part of the siphon cemented in, as a receptacle. *b*, Perforated stopper, for the place of the old valve.

## No. 50.

### *List of American Patents.*

(Continued from page 237.)

1798.

Nathan Read, Jan. 8, machine for cutting and heading nails.

Thomas Bruff, senior, Jan. 8, improvement in grinding coffee.

John Dixey, Jan. 24, machine for printing paper, leather, &c.

Isaac Tryon, Feb. 22, improvement in cutting and pointing comb-teeth.

Charles Holden, March 15, improvement in wind-mills.

Samuel Blydenburg, March 22, machine for dipping candles.

Robert M'Kean, March 24, steam saw-mill.

Aaron Clarke, March 30, mill for sawing boards.

Elijah Ormsbee, March 21, screw engine for throwing water.

John Manning, April 10, improvement in raising water from fountains.

John Martin, April 27, regulating the action of the tide on his spiral wheel.

Mark Isambard Brunel, April 27, machine for raising water.

Isaac Lazell, May 18, machine for removing rocks, &c.

James Smallman and Nicholas J. Roosevelt, May 31, a double steam engine.

Thomas C. Martin, June 2, machine for threshing wheat, &c.

Charles Stoudinger, June 2, machine for propelling vessels.

Walter Brewster, June 7, water-wheel flume for large streams.

Jonathan Hunt, June 7, an oblique pump.

John Love, June 11, "a tallow lamp."

Samuel Cooley, June 6, a composition for pills.

John W. Godfrey and W. Lane, July 14, improvement in stoves.
R. Peale, Dec. 14, method of preserving vessels, &c. from worms.
William Banks, December 14, improvement in making bread.
David Wilkinson, December 14, machine for cutting screws.
Cyrus Austin, Dec. 14, improvement in manufacturing paper.
Mark Reeve, Dec. 14, pipes and pumps for conveying water.
S. Colver, Dec. 14, machine for clearing docks and harbours.
S. Colver, Dec. 14, machine for heaving down vessels, raising weights, &c.

1799.

Joseph Huntley, Jan. 10, machine for raising water.
Mark I. Brunel, Jan. 17, machine for writing with two pens.
Thomas Thompson, Jan. 3, method of regulating wind-mills.
Seth Hart, Jan. 4, machine for making nails.
John Sears, Jan. 24, machine for manufacturing salt.
Henry Abbot, Jan. 24, improvement in a coal stove.
E. Spooner, Jan. 25, machine for cultivating corn, beans, &c.
Eliakim Spooner, Jan. 25, machine for planting corn, beans, &c.
E Reed, Feb. 14, improvement in a horizontal water-wheel.
Benjamin Dearborn, Feb. 14, improvement in steelyards.
B. Du Val, Feb. 14, preparation of steel for cutting glass.
Jacob Perkins, Feb. 14, improvement in making nails.
Benjamin Tyler, Feb. 26, a flax and hemp mill.
William Hancock, Feb. 26, improvement in casting iron.
Charles Whiting, March 2, extracting oil from cotton seeds.
John Shotwell, March 16, improvement in sharpening axes, &c.
Jacob Perkins, March 19, a check to detect counterfeits.
Josiah Shackford, March 21, improvement in propelling boats.
Isaac Sandford, March 27, machine for dressing cloth.
Samuel Morey, March 27, obtaining force from water by steam.
Phineas Pratt, April 12, machine for making combs.
Samuel Morey, April 24, improvement in his water engine.
B. Dearborn, April 30, double-centered mill for wind or water.
Andrew W. Duty, May 8, new method of cutting clay for tiles.
William Farris, May 17, machine for raising water.
C. Gould, May 27, "machine to keep a ship's distance at sea."
M. Wigglesworth, June 26, improvement in making ropes.
Samuel H. P. Lee, June 26, "bilious pills."
Ezra Weld, June 26, improvement in washing clothes.
James Long, Aug. 5, napping hats.
Richard Robotham, Aug. 14, purifying spermaceti oil.

Samuel Eli Hamlin, Aug. 30, a capstan fire-engine.
Moses M'Farland, Oct. 28, federal balloon.
Robert R. Livingston, Oct. 28, manufacturing of paper.
Apollos Kinsley, Oct. 28, universal pump.
Daniel Keller, Nov. 5, boat for descending rapid streams.
John Stickney, Nov. 29, pumps for ships, mines, &c.
Thomas Payne, Dec. 2, saw-mill.
John G. Gebhard, Feb. 4, extracting oil from Palma Christi.
John Hawks, Dec. 14, Hawks' pills.
Havilard Chase, Dec. 16, improvement in mills.
J. Pitman, Dec. 24, "effeminate ropery for spinning rope-yarn."

1800.

Oliver Evans, Jan. 16, improvement on stoves and grates.
S. Gorham, Feb. 4, machine for spinning rope yarn and twine.
S. Constant, Feb. 4, composition to preserve wood, brick, &c.
B. Bolitho, Feb. 7, machine for pounding rice, gunpowder, &c.
W. Shotwell, Feb. 7, metal boxes for wood or iron to turn in.
John J. Hawkins, Feb. 12, improvement in piano fortes.
Hattil Killey, 2d, Feb. 12, method of covering salt vats from the weather.
Nathaniel Ladd, Feb. 12, extracting the essence of sumach, fera, &c. for tanning.
Patrick Lyon, Feb. 12, engine for throwing water.
James Cox, Feb. 20, raising or lifting hides in tanning.
Benjamin Tyler, Feb. 20, improvement in grist mills.
John Percy, March 3, improvement in dying blue.
William Harris, March 15, lathe or loom for weaving.
C. Hoyt, jun. April 7, machine for manufacturing sumach.
William Hottensteen, April 10, improvement in coach collars.
Peter Walker, April 10, stop cock.
Dean Howard, April 10, improvement in the manufacture of boots and shoes.
Silas Stone, May 6, improvement in the elastic truss for ruptures.
John Biddis, May 6, engine for reducing silk, cotton, worsted, cloth, &c. to their original state, to be manufactured.
Simeon Jocelin, May 8, silent moving time-keeper.
Jeremiah Brown, May 14, improvements in the construction of ships and vessels.
George Hadfield, May 15, machine for making bricks and tiles.
Edward West, May 19, metal amulets.
T. O. Harrison, May 19, machine for splitting hides and skins.

Robert Smith, May 19, mould board of a plough.

William Shotwell, June 24, cogs, &c. for pullies.

Peter Lorillard, June 28, machine for cutting tobacco.

James Deneale, jun. July 10, kiln for drying grain.

Peter Lossing, Aug. 4, improvement in burning lime, &c.

Frederick Butler, Aug. 22, machine for cooking.

Frederick Young, Aug. 23, machine for cutting and heading nails.

Jonathan Kilborn, Aug. 23, machine for cutting tanner's bark.

David Cooley, jun. and Gabriel N. Philips, Aug. 25, improvements in chimneys.

Ezra Weld, Sept. 17, "Lavater," machine for washing and wringing clothes.

Richard Mansfield, Oct. 24, improvement in manufacturing bricks.

Aaron Brookfield, Oct. 24, raising water for mills.

John J. Hawkins, Oct. 24, improvement in musical instruments.

Jonathan Grout, jun. Oct. 24, telegraph (description) filed.

Samuel Murray, Nov. 17, obtaining force from water, with the assistance of steam.

William Young, Nov. 20, hanging windows without weights.

1801.

John Cannon, Jan. 17, machine for breaking flax.

Jesse Wheaten, Jan. 17, jaundice bitters.

Ebenezer Whiting, Jan. 22, cotton gin.

Henry Guest, Jan. 26, improvement in sheathing vessels.

Alexander Anderson, Jan. 26, brewing with Indian corn.

Do. Jan. 28, condenser for heating wash in distilling.

Joseph Strong, Jan. 29, axle tourniquet.

William Henderson, Feb. 12, improvement in the construction of stoves.

Thomas Bedwell and Benjamin Henfrey, Feb. 12, improvement in evaporation.

Michael Garber, Feb. 20, machine for making and heading nails.

Barnabas Langdon, Feb. 20, hydraulick machine for raising water.

David Grieve, Feb. 20, improvement in boats to ascend rivers, &c.

Benjamin Henfrey, March 2, increasing the surface of evaporation for the purpose of distilling.

Richard Weems, March 16, boring machine for posts for fencing.

William Stillman, March 16, veneering plough for cabinet work.

John Strong, March 24, hydraulick engine.

Israel Hatch, March 24, making and discharging chain and cleaver shot.

Nathan Kent, May 1, cut nails from iron hoops, &c. rendered tough.

David Ellicot, May 1, stove, screw, and reel grain drying machine.

Solomon Thayer, June 9, impellent pump.

Jesse Reed, June 9, nails milled out of heated rods.

Samuel Downing, June 12, extract of bark for dying, &c.

John Eveleth, June 13, forcing pump.

Charles W. Peale, July 16, portable vapour bath.

Henry Guest, July 16, infusing oil into leather, &c.

Jeremiah Ladd, July 17, a beaming machine.

Caleb Green, July 23, mill for grinding painter's colours, &c.

Christopher Hoxie, Aug. 20, machine for extracting grain from straw, &c.

William Palmer, Aug. 25, a machine for raising water.

Gurdon F. Saltonstall, Aug. 21, improvement for cooling and conveying up meal, &c.

Gurdon F. Saltonstall, Sept. 2, metallick fluted gin rollers, for cleaning cotton.

Thomas Bruff, Sept. 14, manufacturing spoons.

James Sharples, Sept. 15, giving motion to wheels within cylinders.

Do. mechanical powers for the use of windmills, &c.

Thomas Power, Sept. 19, manufacturing potash.

Samuel Willis, Sept. 21, moveable suspended beam and scale.

Richard Robothom, Oct. 10, air-pump ventilator for ships, mines, &c.

Richard Robotham Oct. 10, machine for ruling paper, &c.

John Poole, Oct. 13, a syphonick steam machine.

Michael Krafft, Oct. 28, construction of stills.

William Leslie, Nov. 5, machine for cutting and heading nails.

John A. Morton, Dec. 16, improvement in a windmill.

George Clymer, Dec. 22, improvement in a ship's pump.

Jos. Condit, jun. Dec. 28, making paper from currier's shavings.

1802.

Joseph Hutton and Gideon Fairman, Jan. 8, improvement in the art of engraving.

Rufus Hathaway, Jan. 20, improvement in a wind-mill.

Simon Willard, Feb. 8, improvement in a time-piece.

Isaac Baker, Feb. 20, a machine for churning.

Thomas B. Whilock, Feb. 23, improvement in boxes for carriages.

Richard Claiborne, Feb. 23, improvement in paddles for propelling boats.

Nathaniel Robbins, March 11, improved mode of carrying fish in warm weather.

Jacob Warrel, March 17, machine for cutting and grinding bark.

John Biddis, March 22, manufacturing starch from potatoes.

John W. Holly, March 27, improvement in a grist mill.

Moses Coates, April 1, improvement in a saw mill, which returns the log after each cut.

Ebenezer Whiting, April 1, improvement on a block macking gang-lathe.

William Bell and Samuel de Montmollin, April 7, machine for ginning cotton.

Joel Pierce, April 10, machine for churning.

Benjamin Henfrey, April 16, improvement, being a cheap mode of obtaining light from fuel.

Samuel Downing, April 19, extracting the essence of bark for dying.

Asher Spicer, April 22, machine for cleaning clover seed.

Hezekiah Richardson, jun. and Levi Richardson, April 28, improvement in a saw mill.

Henry Abbott, May 4, machine for rolling iron round, &c.

Do. improvement in casting close stoves.

Henry Johnson, May 10, improvement in flat roofs for houses and balconies.

Burgiss Allison, May 12, mode of improving spirits.

Lewis du Pré, May 12, scientific steelyards.

Benjamin Ellicot, May 12, machine for manufacturing salt.

Andrew Law, May 12, new plan for printing music.

Nicholas Young, May 14, machine for cutting fur for the use of hatters.

Edward West, July 6, machine for cutting nails.

Do. improvement in heading and cutting nails.

Do. improvement in a gun lock.

Do. improvement in a steam boat.

Jacob Perkins, July 9, improvement in pumps.

Stephen Stilwell, July 9, machine for cleaning wheat.

John Greenleaf, July 13, machine for cleaning out docks.

Jesse Reed, July 15, method of rolling iron for nails.

Ezekiel Miller, July 19, improved machine for threshing and cleaning wheat.

Ezekiel Miller, July 17, machine for making bricks.

Martin Miller, July 19, machine for cleaning clover seed.

Joseph Pope, July 22, machine for threshing grain.

Thomas H. Rowson, July 24, antibilious pills.

Nathan Forbes, Aug. 2, machine for making nails.

James Templeton, Aug. 17, improvement in a trigonometrical quadrant.

William Paine, Aug. 24, improvement in a still.

Elisha Putnam, Aug. 24, improvement called a fire-stop.

Nicholss Boureau, Aug. 30, economical house and ship steam kitchen.

Matthew C. Groves, Sept. 3, astronomical quadrant.

Benjamin S. Walcott, Sept. 4, machine for heading nails.

Leonard Kennedy, Sept. 7, improvement in fastening, in raising and supporting window sashes.

John Richardson, Sept. 13, an evaporating furnace.

Jacob Idler, Sept. 24, machine for pressing cotton or other bale goods.

Samuel Briggs, jun. Oct. 9, improvement in a steam engine.

John Baptiste Aveilhé, Oct. 14, machine for raising water, [a perpetual motion !!!]

Asa W. Chickering, Nov. 29, improvement in splitting skins.

Benjamin Gorton, Nov. 29, improvement in extracting neutral salts from alkaline.

John Gardiner, Dec. 3, improvement in erecting dry docks.

William Caruthers, Dec. 13, machine for making nails.

James Cowen, Dec. 14, improvement in the construction of mill wheels.

John Staples, Dec. 15, improvement in stills.

Valentine Peers, Dec. 18, improvement in making salt.

Timothy Kirk, Dec. 28, improvement in a boiling cistern.

Simon Lozarus, Dec. 21, antibilious stomach cordial.

Daniel Pettibone, Ezekiel Chapman, and Josiah Nicols, Dec. 22, improvement in the manner of welding cast steel to iron, &c.

Abraham Du Buc Marentille, Dec. 23, an insubmersible boat.

Burgiss Allison and John Hawkins, Dec. 30, improvement in manufacturing paper from corn husks.

William Palmer, Dec. 31, machine for sawing stone and marble.

## *List of English Patents.**

(Continued from Page 237.)

1796.

John Luke, Esq. July 4, machinery for lifting, drawing, and conveying loaded and light vessels from one canal to another.

Valentine Close and James Keeling, July 5, improvements in ovens, kilns, and firing-places; firing, hardening, and baking, porcelain and earthen wares, &c.

Gabriel Aughtie, July 20, a coffin, so secure, as to render it impracticable either to break, cut, or otherwise open it.

Robert Hoakesly, July 20, making British potash, for all kinds of manufactures in which foreign potash, or any alkali, is useful.

Henry Walker, July 20, method of erecting houses, &c. in one entire mass or body.

Thomas Potts, July 20, machine attached to the stern of any vessel, boat, or barge, for moving it.

Charles Haley, Aug. 17, marine timekeeper, for the better ascertaining the longitude at sea.

Samuel Guppy, Aug. 19, method of cutting and heading nails, whereby much labour is saved.

Arnold Wilde and Joseph Ridge, Aug. 25, method of making saws, and divers other articles, of iron and steel united, also of iron or steel.

Francis Lowndes, Sept. 9, machine for exercising the human body.

Thomas Cooper, Sept. 9, machine for mashing or mixing malt, for the purpose of brewing or distilling, by means of which both a vertical and horizontal motion is produced.

Ralph Wedgwood, Oct. 3, method of making earthen ware, whereby that article may be made at a less cost than hitherto.

Ralph Wedgwood, Oct. 3, composition for making glass upon new principles.

Ralph Wedgwood, Oct. 3, stove upon a new principle.

John Pepper, Oct. 3, mode of building ovens and kilns, for firing and burning of china, earthern ware, bricks, tiles, and other earths and compositions.

Edward Thomason, Oct. 25, steps for coaches, chariots, &c.

John Steedman, Oct. 31, machine for threshing corn.

Edmund Lloyd, Oct. 31, teakettle or teaboiler on a new construction, boiling water more expeditiously, and at much less expense.

* Repertory, vol. 7.

John Russel, Nov. 5, an apparatus, named *Selenographia*, to exhibit the phenomena of the moon.

John Davidson, Nov. 7, machine for doubling, twisting or making, reeling, and skaining, worsted, thread, silk, cotton, &c. which requires only one person to work, manage, and direct.

William Raley, Nov. 10, horizontal turning churn, which is easily worked, collects the butter sooner, and is easier kept clean, than those in common use.

Thomas Cobb, Nov. 19, method of making coloured paper, which may be used as well for hanging rooms, as for writing, printing, drawing, &c.

Charles Trusted, Nov. 24, machine called a time-repeater, to be applied to common watches, for the purpose of striking the hours and quarters.

William Jackson, Dec. 5, improvement upon doors, whereby the door shuts of itself, without noise.

James Tate, Dec. 5, machine for cooking, on improved principles.

John Gover, Dec. 8, carriage for all sorts of cannon, whereby the working and management of them may be done with less difficulty and labour.

Francis Lloyd, Dec. 13, furnace or fire-place calculated to save expense in fuel.

Moses Lafount, Dec. 23, a plate and hoop or band, to be used in mounting glass chandeliers, &c.

1797.

John Lee, Jan. 23, mixture of chalk, whiting, or lime, together with clay, loam, or earth, for colouring and making bricks.

Dudley Adams, Jan. 23, spectacles upon a new principle, by which all pressure is removed from the temples and nose.

Anthony George Eckhardt and Richard Morton, Jan. 23, making candlesticks, &c. so that the lights may be raised or lowered, having likewise the advantage of an extinguisher.

Timothy Sheldrake, Jan. 24, method of curing the deformities of children, or others.

Robert Ferryman, Jan. 24, machine for blanching, grinding, and dressing of corn.

James Murphy, Jan. 27, improvements in tanning hides and skins, &c.

William Rolfe and Samuel Davis, Jan. 31, improvements in harpsichords and piano-fortes.

George Cotes, Jan. 31, machine for expediting the making of horse-shoe nails, brads, &c.

John Grover, Feb. 7, improvements in the construction and fixing of coppers, boilers, and furnaces.

John Falconer Atlee, Feb. 7, method of condensing and cooling spirits, in the process of distillation.

James Glazebrook, Feb. 7, method of working and giving power to machinery, by means of air.

John Nash, Feb. 7, method of constructing bridges of plate-iron, &c.

Aaron Garlick, Feb. 7, machine for spinning and roving of cotton.

Nicolas Dubois Dechemant, Feb. 15, table with a stove placed in the centre thereof.

## INTELLIGENCE.

### *English Incendiary Fusees Examined.*

The commandant in chief of the isle of Oleron, general De Grave, transmitted to the Society of Encouragement at Paris, an incendiary fusee, about a demimetre long, found on board of an English boat, which was wrecked on the coast of France. The society directed its committee of chemical arts to analyse the same; and M. Gay Lussac, in the name of the committee, made the following report on the 2nd of August, 1809.

The fusee which I examined was not entire; it was about three decimeters long, and its internal diameter did not exceed a centimeter. The envelope was formed of several folds of grey paper, pasted on each other, and the whole covered with a coat of oil paint, to resist moisture. The inflammable matter which it contained, had a grayish yellow colour, in which particles of sulphur were easily distinguishable; on being lighted, it burned with a vivid flame about a decimeter and a half long, exhaling a very strong odour of sulphurous acid. The duration of its combustion was from ten to twelve minutes, for a length of three decimeters of the fusee. Having pulverized the inflammable matter, I treated 30.78 grammes with water; the matter which did not dissolve after repeated washings, weighed 7.690 grammes; it consisted of a mixture of sulphur and charcoal. I then treated this mixture with caustic potash, and obtained 0.504 grammes of charcoal; deducting this from the weight of the mixture, I deduced that of the sul-

phur, and concluded, that 100 parts of the fusee were composed of 75 nitre, 1.6 charcoal, 23.4 sulphur.

Having thus determined the nature and proportions of the elements of the fusee, I endeavoured to make a similar one. For that purpose, I took a cylindrical stick of a centimeter diameter, around which I rolled a sheet of grey paper, impregnated with a little glue. I then withdrew the stick; and when the envelope was sufficiently dry, I closed one end with a cork, (*bouchon de liége*) which entered with some difficulty. The envelope thus prepared, I made a mixture in the proportion above indicated, and having reduced it to a hard paste by a little water, I introduced the same into the cylinder, compressing it strongly with a musket ramrod. When the dissication of the mixture was completed, I lighted it; the phenomena which it presented were precisely similar to the English fusees. It burns in a similar manner, with deflagration, and in the same time, as the society may convince themselves by those which I have the honour of presenting to them.

*Arch. des Decouv. de* 1810.

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PRESERVATION OF BUTTER.

One part of sugar, one part of nitre, and two parts of the best Spanish salt, are to be finely pulverized together, and kept for use; one ounce of this is to be mixed thoroughly with 16 ounces of the butter, as soon as it is freed from the buttermilk; it is then to be put into a close and perfectly clean dry vessel, from which the air is to be carefully excluded, and it will remain good for many years.

Johnson's *Animal Chemistry*, vol. 1. p. 149.

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ENGLISH CHEESE.

According to Parkinson, the Stilton is made of the curds from sour and sweet milk mixed together, and the whey pressed lightly out; and the richness depends in some measure on the quantity of cream. It is afterwards turned often, and not dried too quickly. Cheshire cheese is made of new milk, and its rich flavour and mellowness are owing to an addition of sweet beef suet, or any other, which is poured into and mixed with the curd, with a sufficient quantity of salt to keep it from rancidity. It is found that the hotter any kind of cheese is put together, the sounder it will be; and the colder you put it together, the richer it is, and the sooner it will decay. *Idem*, vol. 1. p. 155.



Sir Isaac Newton

Born Dec.$^{r}$ 25$^{th}$ 1642. – Died March 20$^{th}$ 1727.

Emporium of Arts & Sciences

THE

# EMPORIUM

OF

# ARTS AND SCIENCES.

VOL. 1.] OCTOBER, 1812. [No. 6.

## NO. 51.

### *A Treatise on the Cultivation of the Vine, and the Method of making Wines. By* C. CHAPTAL.

(Concluded from page 362.)

### *III. General Precepts respecting the Art of managing Fermentation.*

WHEN the grapes have acquired the proper degree of maturity, if the atmosphere be not too cold, and if the vintage be of the proper volume, fermentation has no need of aid or assistance. But these conditions, without which it is impossible to have a good result, are not always united, and it belongs to art, in order to obtain a good fermentation, to combine all these favourable circumstances, and to remove every thing prejudicial.

The faults of fermentation arise naturally from the quality of the grapes, which are the subject of it; and from the temperature of the air, which may be considered as a very powerful auxiliary.

Grapes may not contain a sufficiency of sugar to produce a sufficient formation of alcohol: and this vice may be owing to the grapes not having attained to maturity, or to the

sugar being diluted in too considerable a quantity of water; or because sugar, by the nature of the climate, cannot sufficiently develope itself. In all cases there are two ways of correcting the vice which exists in the nature of the grapes; the first consists in conveying into the must that principle which it wants: a proper addition of sugar presents to fermentation the materials necessary for the formation of alcohol, and the deficiency of nature is supplied by art. The antients, it appears, were acquainted with this process, since they mixed honey with the must which they caused to ferment. At present, direct experiments have been made on this subject; but I shall confine myself to transcribe here the results of those made by Macquer.

"In the month of October 1776 I procured from a garden at Paris a quantity of the white grapes called *pineau* and *melier* sufficient to make from twenty-five to thirty quarts of wine. They were waste grapes, and taken, purposely, in a bad state of maturity, that there might be no hopes of making potable wine from them: in nearly about a half of them, single grapes and even whole clusters were so green that their acidity was insupportable. Without taking any other precaution than to separate what were putrid, I caused the rest to be bruised with the stalks, and the juice to be expressed with the hand: the must which issued from them was exceedingly turbid, of a dirty-green colour and of a sweetish sour taste, in which the acid predominated so much that it caused those who tasted it to make wry faces. I dissolved in this must a sufficient quantity of brown sugar to give it the taste of pretty good sweet wine; and without boiler, funnel, or furnace, I put it into a cask in an apartment at the bottom of the garden, where it was left to itself. Fermentation took place in it on the third day, and maintained itself for eight days in a very sensible manner, but still very moderate. After that time it ceased spontaneously.

"The wine thence resulting being newly made, and still turbid, had a pretty strong and pungent vinous odour; its taste was somewhat harsh; while that of the sugar had disappeared as completely as if it had never existed. I suffered it to remain in the cask during the winter; and having examined it in the month of March, I found that, without having been drawn off or strained, it had become clear; its taste, though still pretty strong and pungent, was, however, much more agreeable than it had been immediately after the sensible fermentation; it had something sweeter and more racy, but was mixed with nothing that approached to sugar. I then put the wine in bottles, and having examined it in the month of October 1777, I found it to be clear, fine, exceedingly brilliant, agreeable to the taste, generous, and warm; in a word, like good white wine made from pure grapes which has nothing luscious, the produce of a good vineyard in a good year. Several connoisseurs, whom I made to taste it, gave it the same character, and could not believe that it had been made from green grapes, the taste of which had been corrected with sugar.

"This success, which exceeded my hopes, induced me to make a new experiment of the same kind, and still more decisive, on account of the extreme greenness and the bad quality of the grapes which I employed.

"On the 6th of November 1777 I caused to be collected, from the top of an arbour in a garden at Paris, a kind of large grapes which never ripen properly in this climate, and which we know only under the name of *verjus*, because they are used for no other purpose than to express the juice before it becomes spoiled, that it may be employed as a kind of sour seasoning in cookery. Those here alluded to had scarcely begun to rot though the season was far advanced, and they had been abandoned on the arbour as leaving no hope of their acquiring suf-

ficient maturity to be fit for the table. They were still so hard that I resolved to make them burst over the fire in order to extract the juice: the quantity they furnished was about eight or nine quarts. This juice had a very acid taste, in which there could scarcely be distinguished a very slight saccharine savour. I dissolved some of the commonest cassonade* until it appeared to me to be very saccharine. It required a great deal more than for the wine of the preceding experiment, because the acidity of the latter must was much stronger. After the sugar was dissolved, the taste of the liquor, though very saccharine, had nothing agreeable, because the sweet and the sour were perceived pretty strongly and separately in a disagreeable manner.

"I put this kind of must into a jar so as not to be entirely full, and covered it only with a cloth: as the season was already very cold, I placed it in an apartment where the heat was always maintained at 12° or 13 degrees (59 to 61 F.) by means of a stove.

"Four days after the fermentation was not yet very sensible, the liquor appeared to me to be as saccharine and as acid; but these two tastes beginning to be better combined, the result was a whole more agreeable to the taste.

"On the 14th of November the fermentation was in full force: a lighted taper introduced into the empty part of the jar, was speedily extinguished.

"On the 30th the sensible fermentation had entirely ceased, and the taper was no longer extinguished in the interior of the jar. The wine which resulted from it was, however, very turbid and whitish; its taste had scarcely any thing saccharine; it was strong, pungent, and pretty agreeable, like that of generous warm wine, but a little gaseous and green.

"I closed the jar and put it into a cool place, that the

* Brown Sugar.

wine might bring itself to perfection by insensible fermentation during the whole winter.

"Having examined this wine on the 17th of March 1778, I found that it was almost entirely clear, the remains of its saccharine as well as its acid taste had disappeared. The latter was that of pretty strong wine made from pure grapes: it was not unpleasant, but had no perfume or *bouquet*, because the grapes, which we call *verjus*, contain no odorous principle or aroma: these excepted, this wine, which was quite new, and which still had to gain by that fermentation which I call *insensible*, promised to become racy and agreeable."

These experiments seem to me to prove, beyond all doubt, that the best method of remedying the want of maturity in grapes is to follow the process indicated by nature; that is to say, to introduce into the must that quantity of saccharine principle necessary which it could not give them. This method is the more practicable, as not only sugar, but also honey, molasses, and every other saccharine matter of an inferior price can produce the same effect, provided they have no disagreeable accessary taste which cannot be destroyed by good fermentation.

Bullion caused the juice of grapes, taken from his park at Bellegames, to ferment by adding from 15 to 20 pounds of sugar per *muid*.* The wine they produced was of a good quality.

Rozier, long ago, proposed to facilitate the fermentation of must, and ameliorate wines by the addition of honey, in the proportion of a pound to two hundred of must. All these processes depend on the same principle, viz. that no alcohol is produced where there is no sugar; and that the formation of alcohol, and consequently the generous nature of wine, is constantly proportioned to the quantity of sugar existing in the must: it is thence evi-

* 280 quarts.

dent that wine may be carried to any degree of spirituosity required, whatever may be the primitive quality of the must, by adding to it more or less sugar.

Rozier has proved, and the same result may be obtained by calculating the experiments of Bullion, that the value of the produce of the fermentation is very far superior to the price of the matters employed; so that these processes may be presented as objects of economy and matter of speculation.

It is possible also to correct the quality of the grapes by other means, which are daily practised. A portion of the must is boiled in a kettle; it is concentrated to one-half, and then poured into a vat: by this method the aqueous portion is in part dissipated, and the portion of sugar being then less diluted, the fermentation proceeds with more regularity, and the produce is more generous. This process, almost always useful in the north, cannot be employed in the south, but when the season has been rainy or when the grapes have not been sufficiently ripe.

The same end may be attained by drying the grapes in the sun, or exposing them for the same purpose in stoves, as is practised in some wine countries.

It is perhaps for the same reason, always with a view to absorb the moisture, that plaster is sometimes put into the vat, as was practised by the ancients.

It sometimes happens that the must is both too thick and too saccharine: in that case the fermentation is always slow and imperfect; the wines are sweet, luscious, and thick; and it is not till after remaining a long time in the bottles that it becomes clear, loses its disagreeable thickness, and only exhibits good qualities. The greater part of the white Spanish wines are in this situation. This quality of wine has however its partisans, and there are some countries where the must is concentrated for that purpose, in others the grapes are dried in the sun or

in stoves till they are reduced almost to the consistence of an extract.

It would be easy in all cases to excite fermentation, either by diluting the must, when too thick, with water, or by agitating the vintage in proportion as it ferments: but all this must be subordinate to the end proposed to be obtained, and the intelligent agriculturist will vary his processes according to the effect which he intends to produce.

It must never be forgotten, that the fermentation ought to be managed according to the nature of the grapes and agreeably to the quality of the wine that may be required. Burgundy grapes cannot be treated like those of Languedoc. The merit of the one consists in a peculiar flavour, which would be dissipated by a strong and lengthened fermentation: that of the other in the great quantity of alcohol which may be developed in them; and here the fermentation in the vat must be long and complete. In Champagne, the grapes destined for the white brisk wines are collected in the morning before the sun has caused all the moisture to evaporate; and in the same country the grapes destined for making red wine are not cut until they have been well dried by the rays of the sun. In one place artificial heat is necessary to excite fermentation, in another the nature of the must is such that the fermentation would require to be moderated. Weak wines must be fermented in casks, strong wines ought to be suffered to work in the vat. Every country has processes prescribed to it by the nature of its grapes, and it is highly rediculous to attempt submitting every thing to a general rule. It is of importance to be well acquainted with the nature of the grapes employed and with the principles of fermentation: by the help of this knowledge a system of conduct may be formed which cannot fail of being highly advantageous,

because it is founded not on hypothesis but on the nature of things.

In cold countries, where the grapes are very aqueous and little saccharine, they ferment with difficulty: fermentation in that case may be excited by two or three principal means:

1st, By the help of a funnel of tin plate with a very wide tube, which descends to within four inches of the bottom of the vat, and through which boiling must is introduced into it. Two pailfuls may be used for 300 bottles of must. This process proposed by Maupin, has produced good effects.

2d, By shaking the vintage from time to time: this motion is attended with this advantage, that it renews the fermentation when it has ceased or become weak, and causes it to be uniform throughout the mass.

3d, By laying a covering not only over the vintage, but round about the vat.

4th, By heating the atmosphere of the place in which the vat stands.

It often happens that the working of the vintage slackens, or that the heat is unequal through the mass: it is to obviate these inconveniences, especially in cold countries, where they are more frequent, that the vintage is from time to time trod upon. Gentil made two vatfuls, of eighteen butts each, and with grapes from the same vines, and collected at the same time: the grapes were freed from the skins, stalks, &c. and bruised; the juice of both was perfectly equal in quality, and the vintage was put into vats of equal size: the weather, but particularly in the morning and at night, was exceedingly cold.

At the end of some days the fermentation began: it was observed that the centre of the vats was exceedingly warm and the edges very cold; the vats were so close as

to touch each other, and both experienced the same temperature. They were pressed down with a long pole. The cold vintage was pushed from the edges towards the centre where the heat was strongest: it was pressed down several times, and by these means an equal heat was maintained throughout the whole mass. The fermentation in the vat where this process had been followed was finished twelve or fifteen hours sooner than in the other. The wine was far better, it was more delicate, had a superior taste, and was more highly coloured and more generous. No one would have said that it was produced from the same grapes.

The antients mixed aromatic substances with the vintage in a state of fermentation, in order to give their wines peculiar qualities. We are told by Pliny that it was usual in Italy to sprinkle pitch and resin over the vintage *ut odor vino contingeret et saporis acumen.* In all the works of that period we find numerous recipes for perfuming wines; but these different processes are no longer used. I am, however, inclined to think that they were of great benefit. This very important part of oinology deserves the particular attention of the agriculturist. When we consider the custom followed in some countries of perfuming the wines with raspberries, the dried flowers of the vine, &c. we may even presage the happiest effects from it.

Darcet has communicated to me the following facts, which I take the earliest opportunity of publishing here, as they may give rise to experiments proper for improving the art of vinification.

"I took," says he, "a cask called half a *muid,* which I filled with the juice of untrod grapes, and such as had run of itself from the grapes as carried from the vineyard to the press: it therefore had very little colour.

"This cask contained about 150 quarts. I took about thirty quarts, which I evaporated and concentrated to nearly about one-eight of the volume of the liquor; four pounds of common sugar were added, and a pound of grapes *de careme,* after care had been taken to bruise them: the whole, somewhat warm, was then put into the cask, which was filled up with the same must that had been kept apart. A bunch, of about half an ounce, of absinthium, dried and well preserved, was then put into the cask, and the cask was slightly covered, with its lid inverted: fermentation soon took place, and proceeded in a brisk and free manner.

"Besides this piece of must, I caused to ferment also a jar of the same containing about twenty-five or thirty quarts, with half an ounce of sugar per quart: this wine fermentated very well in this jar, and it served me for filling up during the fermentation and after the first drawing off, which was performed at the usual time, and repeated a year after: it was afterwards put into bottles at the expiration of a year, or in the following winter.

"This wine was made in September 1788, during fine weather, and in a very good year.

"It kept very well even in the bottle, it neither became sour nor turbid at the end of several days; I have still two or three bottles of it: it begins to fade."

### *IV. Ethiology of Fermentation.*

The phænomena and result of fermentation are so highly interesting in the eyes of the chemist and the agriculturist, that, after having considered them merely under a practical point of view, we must now consider them under the relation of science.

The two phænomena which seem most worthy of attention from the chemist, are the disappearance of the saccharine principle and the formation of alcohol.

As in fermentation there is no absorption of air, nor addition of any foreign matter, it is evident that all changes which take place in the operation can be referred only to the departure of those substances which are volatilised or precipitated.

Thus, by studying the nature of these substances, and ascertaining their constituent principles, it will be easy for us to judge of the changes which must have been produced in the nature of the first materials of fermentation.

The materials of fermentation are the sweet and saccharine principle diluted in water. This principle is formed of sugar and extractive matter.

The substance volatilised is the carbonic acid gas, and that precipitated is a matter analogous to the ligneous fibre mixed with potash.

The principal product of fermentation is alcohol.

It is evident that the transition of the saccharine principle to alcohol cannot be conceived but by calculating the difference which must be produced in the saccharine principle by the departure of the principles that form carbonic acid gas which is volatilised, and the deposit which is precipitated.

These principles are, in particular, the carbon and the oxygen: here, then, we find carbon and oxygen taken from the saccharine principle by the progress of fermentation; but in proportion as the saccharine principle loses its oxygen and its carbon, the hydrogen, which forms the third constituent principle, remaining the same, the characters of the latter element must predominate, and the fermenting mass must attain to that point at which it will only present an inflammable fluid.

In proportion as the alcohol is developed, the liquid changes its nature; it no longer has the same affinities, nor, consequently, the same dissolving power. The small quantity of extractive principle which remains after hav-

ing escaped decomposition is precipitated with the carbonat of potash: the liquor becomes clear, and the wine is made.

Vinous fermentation, then, is nothing but the continued departure of carbon and oxygen, which produces on one hand the carbonic acid, and on the other alcohol. The celebrated Lavoisier subjected to calculation all the phænomena and results of vinous fermentation, comparing the products of the decomposition with its elements. He assumed as the basis of his calculations the data furnished to him by analysis both in regard to the nature and the proportions of the constituent principles before and after the operation. We shall here transcribe the results obtained by this great man.*

*Materials of Fermentation for a Quintal of Sugar.*

| | | *lib.* | *oz.* | *dr.* | *gr.* |
|---|---|---|---|---|---|
| Water | | 400 | 0 | 0 | 0 |
| Sugar | | 100 | 0 | 0 | 0 |
| Yeast of beer in paste composed of | Water | 7 | 3 | 6 | 44 |
| | Dry yeast | 2 | 12 | 1 | 28 |
| | Total | 510 | 0 | 0 | 0 |

*Detail of the constituent Principles of the Materials of Fermentation.*

| *lib.* | *oz.* | *dr.* | *gr.* | | *lib.* | *oz.* | *dr.* | *gr.* |
|---|---|---|---|---|---|---|---|---|
| 407 | 3 | 6 | 44 | Of water composed of | | | | |
| | | | | Hydrogen | 61 | 1 | 2 | 71·40 |
| | | | | Oxygen | 346 | 2 | 3 | 44·60 |
| 100 | 0 | 0 | 0 | Sugar composed of | | | | |
| | | | | Hydrogen | 8 | 0 | 0 | 0 |
| | | | | Oxygen | 64 | 0 | 0 | 0 |
| | | | | Carbon | 28 | 0 | 0 | 0 |
| 2 | 12 | 1 | 28 | Dry yeast composed of | | | | |
| | | | | Carbon | 0 | 12 | 4 | 59·00 |
| | | | | Azot | 0 | 0 | 5 | 2·94 |
| | | | | Hydrogen | 0 | 4 | 5 | 9·30 |
| | | | | Oxygen | 1 | 10 | 2 | 28·76 |
| | | | | Total | 510 | 0 | 0 | 0 |

* Elements of Chemistry, p. 190.

## *Recapitulation of the constituent Principles of the Materials of Fermentation.*

| | | lib. | oz. | dr. | gr. | lib. | oz. | dr. | gr. |
|---|---|---|---|---|---|---|---|---|---|
| Oxyg. | Of the water . | 340 | 0 | 0 | 0 | 411 | 12 | 6 | 1·36 |
| | Of the water of the yeast . . | 6 | 2 | 3 | 44·60 | | | | |
| | Of the Sugar . | 64 | 0 | 0 | 0 | | | | |
| | Of the dry yeast | 1 | 10 | 2 | 28·76 | | | | |
| Hydr. | Of the water . | 60 | 0 | 0 | 0 | 9 | 6 | 0 | 8·70 |
| | Of the water of the yeast . . | 1 | 1 | 2 | 71·40 | | | | |
| | Of the sugar . | 8 | 0 | 0 | 0 | | | | |
| | Of the yeast . | 0 | 4 | 5 | 930 | | | | |
| Carb. | Of the sugar . | 28 | 0 | 0 | 0 | 28 | 12 | 4 | 59·00 |
| | Of the yeast . | 0 | 12 | 4 | 59·10 | | | | |
| Azot of the yeast | . . . . . | | | | | 0 | 0 | 5 | 2·94 |
| | | | | | | 510 | 0 | 0 | 0 |

## *Table of the Results obtained by Fermentation.*

| lib. | oz. | dr. | gr. | | | lib. | oz. | dr. | gr. |
|---|---|---|---|---|---|---|---|---|---|
| 35 | 5 | 4 | 19 | Of carbonic acid, composed of | Oxygen . . . | 25 | 7 | 1 | 34 |
| | | | | | Carbon . . . | 9 | 14 | 2 | 57 |
| 408 | 15 | 5 | 14 | Of water composed of | Oxygen . . . | 347 | 10 | 0 | 59 |
| | | | | | Hydrogen . . . | 61 | 5 | 4 | 27 |
| 57 | 11 | 1 | 58 | Of dry alcohol composed of | Oxygen combined with hydrogen . . | 31 | 6 | 1 | 64 |
| | | | | | Hydrogen combined with oxygen . | 5 | 8 | 5 | 3 |
| | | | | | Hydrogen combined with carbon . | 4 | 0 | 5 | 0 |
| | | | | | Carbon combined with hydrogen . . | 16 | 11 | 5 | 63 |
| 2 | 8 | 0 | 0 | Of dry acetous acid, composed of | Hydrogen . . . | 0 | 2 | 4 | 0 |
| | | | | | Oxygen . . . | 1 | 11 | 4 | 0 |
| | | | | | Carbon . . . | 0 | 10 | 0 | 0 |
| 4 | 1 | 4 | 3 | Of saccharine residuum, composed of | Hydrogen . . . | 0 | 5 | 1 | 67 |
| | | | | | Oxygen . . . | 2 | 9 | 7 | 27 |
| | | | | | Carbon . . . | 1 | 2 | 2 | 53 |
| 1 | 6 | 0 | 50 | Of dry yeast composed of | Hydrogen . . . | 0 | 2 | 2 | 41 |
| | | | | | Oxygen . . . | 0 | 13 | 1 | 14 |
| | | | | | Carbon . . . | 0 | 6 | 2 | 30 |
| | | | | | Azot . . . | 0 | 0 | 2 | 37 |
| 510 | 0 | 0 | 0 | | | 510 | 0 | 0 | 0 |

### *Recapitulation of the Results obtained by Fermentation:*

| *lib. oz. dr. gr.* | | | *lib.* | *oz.* | *dr.* | *gr.* |
|---|---|---|---|---|---|---|
| 409 10 0 54 | Oxygen . | Of the water . . | 347 | 10 | 0 | 59 |
| | | Of the carbonic acid . | 25 | 7 | 1 | 34 |
| | | Of the alcohol . . | 31 | 6 | 1 | 64 |
| | | Of the acteous acid . | 1 | 11 | 4 | 0 |
| | | Of the saccharine residuum | 2 | 9 | 7 | 27 |
| | | Of the yeast . . | 0 | 13 | 1 | 14 |
| 28 12 5 59 | Carbon . | Of the carbonic acid . | 9 | 14 | 2 | 57 |
| | | Of the alcohol . . | 16 | 11 | 5 | 63 |
| | | Of the acteous acid . | 0 | 10 | 0 | 0 |
| | | Of the saccharine residuum | 1 | 2 | 2 | 53 |
| | | Of the yeast . . | 0 | 6 | 2 | 30 |
| 71 8 6 66 | Hydrogen | Of the water . . | 61 | 5 | 4 | 27 |
| | | Of the water of the alcohol | 5 | 8 | 5 | 3 |
| | | Combined with the carbon in the alcohol . . | 4 | 0 | 5 | 0 |
| | | Of the acteous acid . | 0 | 2 | 4 | 0 |
| | | Of the saccharine residuum | 0 | 5 | 1 | 67 |
| | | Of the yeast . . . | 0 | 2 | 2 | 41 |
| 0 0 2 37 | Of Azot . | . . . . . . . | 0 | 0 | 2 | 37 |
| 510 0 0 0 | | | 510 | 0 | 0 | 0 |

By reflecting on the results exhibited by these tables, we may clearly see what takes place in the vinous fermentation: it is first observed that, of the 100 pounds of sugar employed, 4 lib. 1 oz. 4 dr. 3 gr. remained in the state of undecomposed sugar; so that the quantity of sugar really subjected to operation was only 95 lib, 14 oz. 3 dr. 69 gr.; that is to say, 61 lib. 6 oz. 45 gr. of oxygen, 7 lib. 10 oz. 6 dr. 6 gr. of hydrogen, and 26 lib. 13 oz. 5 dr. 19 gr. of carbon. But by comparing the quantities it will be found that they are sufficient to form all the spirit of wine, all the carbonic acid, and all the acetous acid, produced by the fermentation.

The effects of vinous fermentation are reduced, then, to the separating into two portions the sugar, which is an oxyd; oxygenating the one at the expense of the other to

form carbonic acid; deoxygenating the other in favour of the former to produce a combustible substance, which is alcohol; so that, if it were possible to combine these two substances, the alcohol and carbonic acid, sugar would be re-formed. It is to be observed also, that the hydrogen and carbon are not in the state of oil in the alcohol; they are combined with a portion of oxygen, which renders them miscible with water: the three principles, oxygen, hydrogen, and carbon, are here, then, still in a kind of state of equilibrium; and, indeed, by making them pass through an ignited glass or porcelain tube, they may be re-combined two and two, and water and hydrogen, carbonic acid and carbon, are again found.

### *V. The Method of taking the Wine from the Vats, and the proper Period for that Purpose.*

At all times agriculturists have considered it as a matter of great importance, to be able, by unerring signs, to discover the most favourable period for taking the wine from the vats; but here, as in other things, they have fallen into the very great inconvenience of general methods. This period ought to vary according to the climate, the season, and the nature of the wine proposed to be obtained, and of other circumstances, which must always be kept in view.

It will be proper for us, therefore, to lay down principles rather than to prescribe methods; for, in our opinion, this is the only way to make ourselves masters of the operations, and to bring together the whole of those phænomena, the knowledge and comparison of which become necessary before any dscision, founded upon certainty, can be given.

Some agriculturists have ventured to determine a fixed period for fermentation; as if it ought not to vary according

to the temperature of the air, the nature of the grapes, the quality of the wine, &c. Others consider as a sign that the wine is fit to be removed from the vats, the sinking down of the vintage, being certainly ignorant that almost the whole of the wines of the North would lose their most valuable qualities, if their removal of the vats were delayed till that time.

There are some countries where it is judged that the fermentation is completed, when the wine, after being put into a glass, exhibits no foam at the top, and no air-bubbles at the sides of the glass. In other places it is thought sufficient to shake the wine in a bottle, or to pour it from one glass into another several times, to ascertain whether there exists any foam. But besides that all new wines give more or less foam, there are many in which that mark of effervescence ought to be preserved, in order that they may not lose one of their principal properties.

In some countries, a stick is immersed in the vat, and speedily drawn out; the wine is then suffered to drop from it into a glass, to see whether a circle of foam is formed in it, which is called *faire la roue*. Some thrust their hand into the refuse, and, applying it to their nose, judge, by the smell, of the state of the vat: if the smell is mild, they allow the wine to ferment some time longer; if it is strong, it is removed from the vats.

Some agriculturists, also, consult only the colour in order to regulate the period of removing the wine from vats. They suffer it to ferment till the colour becomes sufficiently dark: but the coloration depends on the nature of the grapes; and must in the same climate, and produced from the same soil, does not always show the same disposition to acquire colour; which renders this sign exceedingly variable and very insufficient.

It thence follows, that all these signs, taken separately, cannot exhibit invariable results; and that, if we wish to

rest on fixed bases, recurrence must be had to principles.

The object of fermentation is to decompose the saccharine principle: the more abundant, therefore, this principle is, the fermentation must be brisker, or continued for a longer time.

One of the inseparable effects of fermentation is, the production of heat and carbonic acid gas. The first of these results tends to volatilize and to disperse the flavour and smell, which forms one of the principal characters of certain wines. The second carries outwards, and causes to be lost in the air a fluid, which if retained in the beverage would render it more agreeable and pungent. From these principles it follows, that weak wines, but of an agreeable flavour, require little fermentation; and that colourless wines, the principal property of which is to be brisk, ought to remain scarcely at all in the vats.

The most immediate product of fermentation is the formation of alcohol, which results immediately from the decomposition of the sugar. When the grapes, therefore, are very saccharine, such as those of the south, the fermentation must be brisk, and long continued; because these wines, being destined for distillation, ought to produce immediately all the alcohol that can result from the decomposition of the whole of the saccharine principle. If the fermentation be slow and weak, the wines remain luscious, and do not become warm and agreeable till they have long worked in the vats.

In general, grapes abundant in the saccharine principle must ferment a long time. In the Bordelois, the fermentation is suffered to work itself to an end: the wine is never removed from the vats till the heat has subsided.

According to these principles and others, deduced from the theory before established, we may draw the following consequences:

1st, The must ought to remain in the vats the less time according as it is less saccharine. Light wines, called in Burgundy *vins de primeur,* cannot bear the vat above from six to twelve hours.

2d, The must ought to remain the less time in the vats, according as it is proposed to retain the acid gas, and to form brisk wines: in that case, it is thought sufficient to tread the grapes, and to put the juice into the casks after it has been left in the vat twenty-four hours, and sometimes without having been in the vat at all. In this case, the fermentation, on the one hand, is less tumultuous; and, on the other, the gas can with less ease be volatilized; which contributes to retain that highly volatile substance, and to make it one of the principles of the liquor.

3d, Must ought to be left in the vats less time, according as it is proposed to obtain wine less coloured. This condition is of great importance in regard to brisk wines, one of the most valuable qualities of which is their want of colour.

4th, Must ought to remain in the vats less time, according as the temperature is warmer, and the mass more voluminous, &c.: in that case, the briskness of the fermentation makes up for its shortness of duration.

5th, The must ought to remain in the vats less time, according as it is proposed to obtain wine of a more agreeable flavour.

6th, The fermentation, on the other hand, will be longer, according as the saccharine principle is more abundant, and the must thicker.

7th, It will be longer if the wines are destined for distillation; in which case, every thing ought to be sacrificed to the production of alcohol.

8th, The fermentation will be longer, according as the temperature has been colder when the grapes were collected.

9th, The fermentation will be longer, according as the wine is required to be more coloured.

From these principles it may be conceived why in one country the fermentation in the vat terminates in twenty-four hours, while in others it continues for twelve or fifteen days; why one method cannot be generally applied; and why particular processes may be attended with errors, &c.

Gentil admits as an invariable sign of the necessity of removing the wine from the vat, the disappearance in regard to taste of the sweet and saccharine principle. This disappearance, as he observes, is only apparent, but the savour of the little that remains is concealed; the alcohol, the savour of which predominates, terminates its decomposition in the casks. It is also evident that this sign, which is not at all applicable to white wine, cannot be employed for wines destined to remain luscious.

The signs deduced from the sinking down of the head or refuse, and the coloration of wines, are attended with the like inconveniences, and we must return from them to the principles above established. This is the only method of avoiding error.

A provident agriculturist will always pepare his casks, on the approach of the vintage, in such a manner that they may be ready to receive the wine as it comes from the vat. The preparation given to them is as follows:

If the casks are new, the wood of which they are composed retains an astringency and bitterness, which may be transmitted to the wine; and these faults may be corrected by pouring warm water and salt water into them several times in succession. These liquors must be well shaken, and suffered to remain in them till they penetrate the texture of the wood, and extract the pernicious principle. If the casks are old, and have been frequently employed, one end of them is opened: the stratum of

tartar, with which the inside is covered, is scraped off, and they are washed with warm water or with wine.

In general, the most usual methods of preparing the casks are confined to the following :

1st, Wash the cask with cold water, then pour into it a quart of salt water in a state of ebullition; stop the bunghole, and shake it in every direction : empty it, let the water drain well off; then take two quarts of fermenting must, and, having boiled and skimmed it, pour it boiling hot into the cask ; close it and again shake it, after which suffer it to drain off.

2d, Warm wine may be employed instead of the above preparations.

3d, An infusion of the flowers of the peach-tree, &c. may also be used.

When the casks have acquired any bad quality, such as mustiness, &c. they must be burnt : it is possible to conceal these defects, but there is reason to fear they might reappear.

The antient Romans put gypsum, myrrh, and various aromatic substances into the casks into which their wines were removed from the vat. This is what they called *conditura vinorum.* The Greeks sometimes added a little bruised myrrh and argil. These substances not only perfumed the wine, but served also to clarify it.

When the casks are properly prepared, they are deposited on cask-stands, and thus raised some inches from the ground, both to prevent the action of putrid humidity, and for the more convenient drawing off the wine which they contain. They must be arranged in parallel rows in the cellar, with sufficient room between for a person to examine whether any of them leaks.

In the casks thus prepared the wine is deposited : when it is thought to have remained a sufficient time in the vat for this purpose, the tap of the vat, which is raised some

inches above the ground, is opened, and the wine is suffered to run into a reservoir, generally constructed below, or into a vessel placed on purpose to receive it: the wine is immediately drawn from the reservoir and carried to the casks, into which it is introduced by means of a funnel.

The liquor which floats over the deposit of the vat is called in Burgundy *surmoût*. This *surmoût* is carefully drawn off, and put into casks capable of containing 30 gallons, or into half casks of 15. This *surmoût* forms a lighter kind of wine, more delicate and less coloured.

When all the wine which the vat can furnish has been drawn off, nothing remains but the head, which has sunk down almost to the deposit. This refuse is still impregnated with wine, and retains such a quantity, that it may be extracted by means of the press. But as the head, which has been in contact with the atmospheric air, for the most part contracts a little acidity, especially when the vintage has remained a long time in the vat, it must be carefully separated, in order to be pressed by itself; by which means it will produce very good vinegar.

When the deposit in the vat has been pressed, the wine that flows from it is put into the casks with the rest; after which the press is eased, and the refuse is cut quite round, to the thickness of three or four inches, with a sharp shovel; that which has been cut off is thrown into the middle, and again subjected to the press: the operation of cutting is a second time repeated, and the cut matter is pressed as before.

The wine arising from the first *cutting* is the strongest; that arising from the third is harder, harsher, greener, and more coloured.

Sometimes a first cutting is thought sufficient, especially when the refuse is destined for the acetous fermentation. The product of these different cuttings is often mix-

ed together in separate casks, in order to obtain wine coloured and pretty durable; and in some places it is mixed with common wine when it is required to give to the latter colour, strength, and a slight astringency. In Champagne, the wine of the first pressing is mixed with that arising from succeeding cuttings.

The wine of the press is the less coloured according as it is pressed more weakly and more speedily. These wines in Champagne are called *gray wines*. The wine arising from the first and second cutting is called *œil de perdrix*; and that arising from the third and fourth, *vin de taille*: the last is the most coloured, but it is still agreeable.

The refuse, when strongly pressed, acquires sometimes the hardness of stone. It is applied to various uses in commerce.

1st, In some countries it is distilled in order to make a spirit, which is called *eau-de-vie de marc*. In Champagne it is known under the name of *eau-de d'Aixne*; but it has a bad taste. This distillation is advantageous, especially in countries where the wine is highly generous, and where the presses do not press very closely.

2d, In the neighbourhood of Montpellier, the refuse is put into casks, where it is carefully trod upon; and it is then preserved for making verdigris*.

3d, In other places it is rendered acid by carefully airing it, and the vinegar is then extracted by strong pressure. The expression may even be facilitated by moistening it with water.

4th, In several cantons the cattle are fed with the refuse: as it comes from the press, it is broken with the hands in order to divide the lumps; it is then thrown into casks, where it is moistened with water, aud it is covered with earth mixed with straw: this covering is about 7 or

* See Philosophical Magazine, Vol. IV.

8 inches in thickness. When bad weather prevents the cattle from going out into the fields, about 6 or 7 pounds of this refuse is soaked in warm water with bran, straw, turnips, potatoes, and oak or vine-leaves, which have been preserved on purpose in water: a little salt may be added to this mixture, which is given to the cattle in a tub evening and morning. Horses and cows are fond of this food; but it must be given to the latter in moderation, because it would cause their milk to turn sour. The refuse of white grapes is preferred on account of its not having been fermented.

5th, The stones contained in the grapes serve for feeding poultry: oil, also may be extracted from them.

6th, The refuse may be burnt to obtain alkali: 4000 pounds of refuse yield 500 pounds of ashes, which give 10 pounds of dry alkali.

### *VI. Of the Method of managing the Wine in the Casks.*

The wine deposited in the casks has not reached its last degree of preparation. It is turbid, and still ferments; but, as the movement of it is less tumultuous, this state of it has been called the *insensible fermentation.*

Soon after the wine has been put into the cask, a slight hissing is heard, which arises from the continued disengagement of the carbonic acid gas that escapes from every point of the liquor; foam, which passes over through the bunghole, is formed at the top, and care is taken to keep the cask always full, that the foam may escape, and that the wine may disgorge itself. For a short time it will be sufficient to fasten a piece of paper on the bung, or to lay a tile over it.

In proportion as the fermentation decreases the mass of the liquid sinks down; and this depression is carefully watched, in order to pour in more wine, that the casks may be always kept full. There are some countries where

this operation is performed every day for the first month, every four days during the second, and every eight till it is drawn off. This is the method practised in regard to the delicious wines of the Hermitage.

In Champagne, the *gray wines* are suffered to ferment in the casks ten or twelve days; and when they cease working up, the casks are closed by means of the bung, leaving a small vent-hole at one side of it. This vent-hole is closed eight or ten days after with a wooden peg, which may be taken out at pleasure. When the casks have been closed, fresh wine must be poured in through the vent-hole, every week for twenty-five days; then every two months as long as the wine remains in the cellar. When the wines have not sufficient body, and are too green, which is the case when the season has been damp and cold; or if they are too luscious, which is the case when the season has been too dry and warm, the casks are rolled five or six times twenty-five days after the wine has been made, to mix well the lees; and this operation is repeated every eight days during a month: by these means the wine is improved.

The fermentation of the wines of Champagne destined to be brisk is continued very long: it is believed that wine can constantly be brisk, provided it be put into bottles between the time of the vintage till the month of May; and that, the nearer to the time of the vintage, the better it foams. We are assured also that it always foams if put into bottles between the 10th and 14th of March. Wine never begins to foam till six weeks after it has been put into bottles. Mountain wine foams better than Champagne: when wine is put into flasks between June and July it foams little, and not at all if bottled in October or November, after the vintage.

In Burgundy, when the fermentation in the cask has slackened, the casks are closed, and a small hole is made

in them near the bung, which is closed with a peg. This peg is drawn out from time to time to suffer the remainder of the gas to escape.

In the environs of Bordeaux it is customary to begin pouring in new wine eight or ten days after the wine has been put into the casks. A month after, the bung is put in, and new wine is poured in every eight days: at first, the bung is put in very gently, and it is gradually driven in closer without incurring any danger.

The white wines are drawn off about the middle of December, and they are then sulphured. The white require more care than the red, because they contain more dregs, and are more disposed to become oily.

Red wines are not drawn off till the end of March or beginning of April. The latter easier turn sour than the white, which renders it necessary to keep them in cooler cellars during the hot weather.

Some people, after the second drawing off, turn the barrels with the bung on one side, and thus keep the wine hermetically sealed, without having need to pour in new wine, as there is no loss. The wine then is not drawn off but every year at the same period, until it is found convenient to drink it. As the processes every where followed are nearly the same, we shall not multiply details, which would be only repetitions.

When the fermentation has ceased, and the mass enjoys perfect repose, the wine is completely made. But it acquires new qualities by clarification; and by this operation is preserved from the danger of turning sour.

This clarification is effected spontaneously by time and repose; and there is gradually formed a deposit at the bottom of the cask and on the sides, which frees the wine from every thing not in absolute solution in it, or which is in it in excess. This deposit, called the lees,

*fæces,* is a confused mixture of tartar principles, analogous to fibrous matter and colouring matter.

But these matters, though deposited in the cask, and precipitated from the wine, are susceptible of being still mixed with it by agitation, change of temperature, &c.; and in that case, besides injuring the quality of the wine, which they render turbid, they may communicate to it a new fermentation, which makes it degenerate into vinegar.

To obviate this inconvenience, the wine is drawn off into other vessels at different periods; all the lees which have been precipitated are carefully separated; and every thing existing in it in a state of incomplete solution is disengaged from it by simple processes, which we shall hereafter detail. By means of these operations it is cleansed and purified, and deprived of all those matters which might determine acetification.

Every thing that relates to the art of preserving wines may be reduced to *sulphuring* and *clarification.*

### *Sulphuring of Wine.*

1st, To sulphur wine is to impregnate it with a sulphurous vapour obtained by the combustion of sulphured matches.

The method of composing these matches varies considerably in different places; some mix with the sulphur aromatic substances, such as powder of cloves, cinnamon, ginger, Florentine iris, flowers of thyme, lavender, marjoram, &c. and melt the mixture in an earthen vessel over a moderate fire. In this melted mixture, rags of cotton cloth are dipped in order to be burnt in the casks. Others employ sulphur alone, which they melt over the fire, and dip rags in it in the same manner.

In the method of sulphuring casks there is also considerable variety. Sometimes the match is suspended at

the end of an iron wire; it is then lighted, and put into the cask intended to be filled with wine; the cask is then stopped, and the match is left to burn: the internal air becomes dilated, and is expelled, with a hissing noise, by the sulphurous gas: two, three, or more matches are burnt in this manner, according as may be thought necessary. When the combustion is terminated, the sides of the cask are scarcely acid; the wine is then poured into it. In other countries, two or three pailfuls of wine are poured into a good cask; a sulphured match is then burnt in it; and when the combustion is finished, the cask is stopped, and shaken in every direction. After being left at rest for an hour or two, it is unstopped, more wine is added; it is then again sulphured, and the operation is repeated till the cask be full. This is the process usually followed at Bourdeaux.

At Marseillan, near the commune of Cette, in Languedoc, a kind of wine is made of white grapes called *mute wine*, which is employed to sulphur others. The vintage is trod and pressed without giving it time to ferment; it is then put into casks filled one-fourth; several matches are burnt over it; and the casks are strongly shaken, until no more gas escapes through the bung-hole when opened. A new quantity of wine is then added, matches are again burnt over it, and the casks are shaken with the same precautions. This operation is repeated till the cask is full. This wine never ferments, and for that reason is called mute wine (*vin muet*). It has a sweetish savour, a strong sulphurous odour, and is employed for mixing with other wine. Two or three bottles of it are put into a cask. This mixture is equivalent to sulphuring.

Sulphuring first renders wine turbid, and gives it a bad colour; but the colour is restored in the course of time, and the wine becomes clear. This operation whitens

the wine a little. Sulphuring is attended with the very valuable advantage of preventing it becoming acetous. Though it be difficult to explain this effect, it appears to me that it cannot be conceived but by considering it under two points of view:

1st, By the help of the sulphurous gas the atmospheric air is displaced, which otherwise would become mixed with the wine, and determine acid fermentation.

2d, Some atoms of a violent acid, which opposes and overcomes the development of a weaker acid, are produced.

The antients composed a kind of mastic with pitch, a fiftieth part of wax, and a little salt and incense, which they employed for burning in their casks. This operation was denoted by the words *picare dolia*, and the wines thus prepared were known under the names of *vina picata*. They are mentioned by Plutarch and Hippocrates. It was, perhaps, in consequence of this custom, that the fir was consecrated by the antients to Bacchus: at present, an agreeable perfume is communicated to weakened red wine by making it remain over a stratum of the shavings of fir. Baccius says that the casks ought to be pitched (*picare dolia*) during the dog days.

### *On the Clarification of Wines.*

2d, Besides the operation of sulphuring wines, there is another, no less essential, called *clarification*. It consists, in the first place, in drawing off the wine from the lees, which requires certain precautions, and in then disengaging it from all the principles suspended or weakly dissolved in it; so that nothing may be retained but the spiritous and incorruptible principles alone. These operations are even performed before that of sulphuring, which is only a continuation of them.

The first of these operations is called drawing off,

transvasation, defecation. According to Aristotle, this operation ought to be often repeated: *quoniam superveniente æstatis calore solent fæces subverti, ac ita vina acescere.*

In the different wine countries there are certain fixed periods of the year for this operation, established, no doubt, on the constant and respectable observation of ages. At the Hermitage, the wine is drawn off in March and September; in Champagne, on the 13th of October, about the 15th of February, and towards the end of March.

Dry, cold weather is always chosen for this operation. It is certain that it is then only that the wine is in a good condition. Damp weather, and southerly winds, always render wine turbid; and care must be taken not to draw it off while these prevail.

Baccius has left us some excellent precepts respecting the most favourable periods for the defecation of wine. He advises the weakest wines, that is to say, those produced from fat covered soil, to be drawn off at the winter solstice; moderate wines, in the spring; and the most generous, during summer. He gives as a general precept, not to draw off wine but when the north wind prevails; and he adds, that wine drawn off at the time of full moon is converted into vinegar!

The manner of drawing off wine can be a matter of indifférence only to those unacquainted with the effect of atmospheric air on that liquid: by opening the tap, or placing a cock at about four inches from the bottom of the cask, the wine which runs off becomes aërated, and determines movements in the lees; so that, under this double view, the wine acquires a disposition to become sour. A part of these inconveniences has been obviated by drawing off the wine by means of a syphon; the motion is then gentler, and by these means one may pene-

trate to any depth at pleasure, without agitating the lees. But all these methods are attended with faults, which have been completely remedied by the help of a pump, the use of which has been established in Champagne and other wine countries.

To a leather pipe, of from four to six feet in length, and two inches in diameter, are adapted at each end wooden pipes, nine or ten inches in length, which decrease in diameter towards the ends, and are fixed to the leather pipe by means of a piece of packthread. The bung of the cask intended to be filled is taken out, and one of the extremities of the pipe is put into it. A good cock is fixed in the cask to be emptied two or three inches from the bottom, and into this is inserted the other extremity of the pipe.

By this mechanism alone, the half of the one cask is emptied into the other: for this purpose nothing is necessary but to open the cock; and the remainder may be made to pass by a very simple process, for which a pair of bellows about two feet in length, comprehending the handles, and ten inches in breadth, are employed. The bellows force the air through a hole formed at the anterior part of the small end: a small leather valve, placed below the small hole, prevents the air from rushing out when the bellows are opened, and to the extremity of the bellows is adapted a perpendicular wooden pipe to convey the air downwards: this tube is fitted into the bung-hole in such a manner, that when the bellows are worked and the air forced out, a pressure is exercised on the wine, by which means it is obliged to issue from the one cask, and to ascend into the other. When a hissing is heard at the cock, it is speedily shut: this is a sign that all the wine has passed.

Funnels of tin plate, the tubes of which are at least a foot and a half in length, that they may be immersed in

the liquor without causing any agitation, are also employed.

Drawing off wine separates a part of its impurities, and consequently removes some of those causes which may alter the quality of it: but there still remain some suspended in the liquor, which cannot be caught but by the following operations, which are called *fining* of wine, or *clarification:* Fishglue (isinglass) is almost always employed for this purpose: it is unrolled with care, and cut into small morsels, and it is then steeped in a little wine, where it swells up, becomes soft, and forms a viscid mass, which is poured into the wine. The wine is then strongly agitated, after which it is left at rest. Some whip the wine, in which the glue has been dissolved, with a few twigs of birch, &c. and by these means occasion a considerable foam, which is carefully removed. In all cases a portion of the glue is precipitated with the principles it has enveloped, and the liquor is drawn off when the deposit is formed.

In warm climates the use of glue is dreaded, and during summer its place is supplied by whites of eggs: ten or twelve are sufficient for half a *muid**. The eggs are first beat up with a little wine; they are then mixed with the liquor intended to be clarified, and it is whipped with the same care. It is possible that gum arabic might be substituted for glue. Two ounces will be sufficient for four hundred pots of wine. It is put into the liquor in the form of a fine powder, and the liquor is then stirred.

Wine must not be drawn off till it is completely made: if the wine is green and harsh, it must be suffered to ferment a second time on the lees, and must not be drawn off till towards the middle of May; if it continues green, it may even be left till the end of June. It even sometimes happens that it is necessary to convey back the wine to

* About a 72 gallon cask English.

the lees, and to mix them strongly, that the wine may again acquire that movement of fermentation which is necessary to bring it to perfection.

We are told by Miller that when Spanish wine becomes turbid by the lees, it may be clarified by the following process: Put the whites of eggs, gray salt, and salt water, into a convenient vessel; skim off the foam formed at the surface, and pour the composition into the wine cask from which a part of the liquor has been drawn off: at the end of two or three days the liquor becomes clear, and acquires an agreeable taste. After being suffered to remain at rest for about a week, it is then drawn off.

To revive claret injured by floating lees, two pounds of calcined flints, well pounded, ten or twelve eggs, and a large handful of salt, are beat up with two gallons of wine, which are then poured into the cask: two or three days after, the wine is drawn off.

These compositions may be varied without end: sometimes starch is employed, and also rice, milk, and other substances, more or less capable of developing the principles which render the wine turbid.

Wine is clarified also, and its bad taste is often corrected, by making it digest over shavings of beech wood, previously stripped of the bark, boiled in water, and dried in the sun or in a stove: a quarter of a bushel of these shavings will be sufficient for a *muid* of wine. They produce a slight movement of fermentation in the liquor, which becomes clear in the course of twenty-four hours.

The art of *cutting wines* (couper du vin), as it is called, (correcting one wine by another—giving a body to those wines which are weak—colour to those destitute of it—and an agreeable flavour to those which have none, or which have a bad one,) cannot be described. In these cases, the taste, sight, and smell must be consulted. The highly variable nature of the substances employed must be studied; and it will be sufficient for us to observe,

that in this part of the management of wines every thing consists: 1st, In sweetening wines, and rendering them saccharine by the addition of *baked must*, concentrated with honey, sugar, or another wine of a very luscious quality. 2d, Colouring the wine by an infusion of turnsole cakes, the juice of elder-berries, logwood, and mixing it with dark, and, generally, coarse wine. 3d, Perfuming it by syrup of raspberries, an infusion of the flowers of the vine suspended in the cask, tied up in a bag, as is practised in Egypt, according to the testimony of Hasselquist.

In the Orleanois, and other countries, a wine is made called there *vin rapé*. It is prepared from picked grapes, which are trod with wine or ley; placing in the press a stratum of vine-twigs and another of grapes in alternate order, or by infusing the twigs in the wine. These wines are made to boil strongly, and they are then employed to give strength and colour to the weak colourless wines of the cold and damp countries.

Though wine may work at all times, there are certain periods of the year at which fermentation seems to be renewed in a particular manner; and, above all, when the vine begins to bud, when it is in flower, or when the grapes begin to become coloured. At these critical moments, wine ought to be watched with particular care; and every movement of fermentation may be prevented by drawing off, and sulphuring it, as above indicated.

When wines are completely clarified, they are preserved in casks, or in glass. The largest vessels are the best, and they ought to be well closed. Every body has heard of the enormous capacity of the tun of Heidelberg, in which wine is preserved for whole centuries, always improving in quality; and it is allowed that wine keeps better in very large casks than in small ones.

The choice of situation in which vessels containing wine ought to be deposited, is not a matter of indifference: on this subject we find among the antients usages and precepts which deviate for the most part from our common methods, but which, in part, are worthy of attention. The Romans drew off the wine from the casks to shut it up in large earthen vessels glazed in the inside: this is what they called *diffusio vinorum.* It appears that for containing wines they had two sorts of vessels, which they called *amphora* and *cadus.* The *amphora* was of a square or cubical form, had two handles, and contained twenty gallons of liquor. This vessel terminated in a narrow neck, which was stopped with pitch or plaster to prevent the wine from exhaling. This we learn from Petronius, who says, *Amphoræ vitreæ diligenter gypsatæ allatæ sunt, quarum in cervicibus pittacia erant affixa cum hoc titulo —" Falernum opimanum annorum centum."* The *cadus* had the figure of the cone of a fir-tree; it contained one-half more than the *amphora.*

The most generous wines were exposed to the open air in vessels well closed; the weakest were prudently placed under cover: *Fortius vinum sub dio locandum, tenuia vero sub tecto reponenda, cavendaque a commotione ac strepitu viarum,* says Baccius. Galen observes that the whole wine was put into bottles, after which it was exposed to a strong heart in close apartments; and in summer it was exposed to the sun on the tops of the houses, that it might sooner become mellow, and fit for drinking. *Omne vinum in lagenas transfundi, postea in clausa cubicula multâ subjecta flammâ reponi, et in tecta ædium æstate insolari, unde citius maturescant ac potui idonea evadant.*

That wine may keep, and improve in quality, it ought to be put into vessels deposited in proper places, the choice of which is not a matter of indifference. Glass

vessels are the most favourable, because, besides their presenting no principle soluble in wine, they shelter it from the contact of the air, from moisture, and the principal variations of the atmosphere. Care must be taken to shut these vessels very closely with good cork; and to lay the bottles on their sides, that the cork may not dry, and facilitate the access of the air. For the greater safety, the cork may be covered with a coating of wax, applied by means of a brush; or the neck of the bottle may be immersed in a mixture of melted wax, resin, and pitch. Some people cover the wine with a stratum of oil; this process is recommended by Baccius. The neck is then covered with an inverted glass tumbler, a vessel of tin plate, or any matter capable of preventing insects or mice from falling into the wine.

The vessels most generally employed for keeping wine are casks, which for the most part are made of oak. They vary in size, and are known by different names, such as pipes, hogsheads, &c. The great inconvenience of casks is, that they not only present to the wine substances which are soluble in it, but that they are affected by the variations of the atmosphere, and afford a passage both to the air which endeavours to escape from them, and to that of the atmosphere which penetrates them.

Glazed earthen vessels have the advantage of retaining a more equal temperature; but they are more or less porous, and at length the wine in them must become dry. In the ruins of Herculaneum vessels were found in which the wine had dried. Rozier speaks of a similar urn discovered in a vineyard in the territory of Vienne in Dauphiny, in a place where the palace of Pompey had formerly stood. The Romans remedied the porosity of earthen vessels by covering them with wax on the inside, and pitch on the outside: they covered also the whole surface with wax cloths, which they applied with great care.

Pliny condemns this use of wax, because, be says, it made the wine turn sour: *Nam ceram accipientibus vasis, compertum est vina acescere.*

Whatever may be the nature of the vessels destined to contain wine, a celler sheltered from all accidents must be chosen.

1st, The exposure of the cellar must be northern: its temperature is then less variable than when the apertures are turned towards the south.

2d, It must be of such a depth that the temperature may be constantly the same. *In cellis quæ non satis profundæ sunt diurni caloris participes fiunt; vina non diu subsistunt integra,* says Hoffman.

3d, The moisture in it must be constant, without being too great: excess of moisture renders the papers, corks, casks, &c. mouldy. Dryness desiccates the casks, and makes them leak.

4th, The light ought to be very moderate: a strong light dries; darkness, almost absolute, rots.

5th, The cellar must be sheltered from shocks. Violent agitation, or that shaking occasioned by the rapid passage of carriages along the street, agitates the lees, mixes them with the wine, where they are kept suspended, and occasions acetification. Thunder, and all movement occasioned by shocks, produce the same effect.

6th, Green wood, vinegar, and all substances susceptible of fermentation, must be kept at a distance from a cellar.

7th. The reverberation of the sun, which, as it necessarily changes the temperature of a cellar, must also alter the properties of the wine preserved in it, ought also to be guarded against.

A cellar, therefore, must be dug to the depth of some fathoms below ground; its apertures ought to be directed towards the north; it must be at a distance from the street,

highways, workshops, sewers, necessaries, &c. and ought to be arched at the top.

### *VII. Maladies of Wine, and the Means of preventing or correcting them.*

There are some wines which improve by age, and which cannot be considered as perfect till a long time after they have been made. Luscious wines are of this kind, as well as all highly spiritous wines; but delicate wines are so apt to turn *sour*, or *oily*, that it is only by means of great precaution they can be preserved for several years.

The first of the principal kinds of wine known in Burgundy, is that of Volney, near Beaune. This wine, so delicate and agreeable, will not bear the vat above 12, 16, or 18 hours, and can scarcely be kept from one vintage to another.

The second of the principal kinds of wine in Burgundy is that of Pomard: it keeps better than the former; but if kept longer than a year, it becomes oily, spoils, and assumes the colour of the peelings of onions.

In every canton the wine has a fixed and known period of duration; and it is every where known that this period must be shorter or longer according to the nature of the season, and the care employed in the process of vinification. No one is ignorant that the wine made from grapes collected in rainy weather, or produced in fat soil, is not of long duration.

The antients, as we are informed by Galen and Athenæus, had determined the epoch of age, or the period at which the different wines ought to be drunk:—Falernum *ab annis decem ut potui idoneum, et a quindecim usque ad viginti annos:* after that period *grave est capiti et nervos offendit.* Albani *vero cum duæ sint species, hoc dulce illud acerbum, ambo a decimo quinto anno vigent.* Sur-

rentinum *vigesimo quinto anno incipit esse utile, quia est pingue et vix digeritur, ac veterascens solum sit potui idoneum.* Tiburtinum *leve est, facile vaporat, viget ab annis decem.* Lubicanum *pingue et inter albanum et falernum putatur usui ab annis decem idoneum.* Gauranum *rarum invenitur, at optimum est et robustum.* Signimum *ab annis sex potui utile.*

The care employed in drawing off wine, and mixing it with *mute* wine, contributes greatly to its preservation. Few kinds are shipped without this precaution. It is of importance then, for the prevention of all its alterations, that all these operations should be multiplied and repeated ; and it is to this valuable practice we are indebted for the power of being able to send wine to all climates, and to subject it to all temperatures, without fear of decomposition.

Among the diseases to which wines are most subject, *oiliness* and *acidity* are the most common and most dangerous.

Oiliness is an alteration which wines often contract : they lose their natural fluidity, and become ropy, like oil.

The less spiritous wines turn oily ; and weak wines, which have fermented very little, are the most disposed to this malady. Weak wines, made from grapes which have been picked, are also subject to it.

Wine turns oily in the best corked bottles. Of this there are too frequent instances in Champagne, where the wine of a whole vintage, when put into glass vessels, is exposed sometimes to this alteration.

Oily wines furnish by distillation but a little fat coloured and oily spirit.

This fault may be corrected several ways.

1st, By exposing the bottles to the air, and, above all, in a well-aired barn.

2d, By shaking the bottle for a quarter of an hour; then uncorking it, and suffering the gas and foam to escape.

3d, By mixing the wine with fish-glue and whites of eggs mixed together.

4th, By introducing into each bottle one or two drops of lemon juice, or any other acid.

From the nature of the causes which produce oiliness in wines, the phænomena exhibited by that malady, and the means employed to cure it, it is evident that this alteration arises from the extractive principle, which has not been sufficiently decomposed.

We find a similar effect in beer, in the decoction of gall-nuts, and in several other cases where the extractive matter, being very abundant, is precipitated from the liquor which held it in solution; and acquires the characters of fibrine matter, unless burned by a fermentation or precipitated by an acid.

Acescence of wine is however the most common malady, and, we may even say, the most natural, for it is almost a consequence of spiritous fermentation; but by knowing the causes which produce it, and the phænomena which accompany or announce it, means may be taken to prevent it. The antients admitted three principal causes of the acidity of wines:—1st, The humidity of the wine: 2d, The inconstancy or variations of the atmosphere: 3d, Commotions.

To know this malady exactly, we must call to mind some principles which can alone furnish us with light on this subject.

1st, Wine never turns sour until the spiritous fermentation is terminated; or, in other words, till the saccharine principle is completely decomposed. Hence the advantage of putting wine into casks before all the saccharine principle has disappeared; because the spiritous fermentation then continues, is prolonged, and removes every

thing that can pave the way for acetous decomposition. Hence the practice of putting a little sugar into the bottle to preserve the wine without alteration; and hence the very general method of baking a part of the must at a slow and moderate heat, and of mixing some of it in the casks intended for embarkation. In some places of Spain and Italy all the must is baked; and Bellon says that the wines of Crete would not keep at sea unless the precaution were taken to boil them.

2d, The least spiritous wines are those which soonest become sour. We know, by experience, that when the season is rainy, if the grapes be little saccharine, which consequently give little alcohol, the wines readily turn sour. The weak wines of the north become sour with great ease; while the strong, generous, spiritous wines obstinately resist acidity.

It is however no less true, that the most spiritous wines furnish the strongest vinegar, though their acetification is more difficult, because alcohol is necessary to the formation of vinegar.

3d, Wine perfectly free from all extractive matter, either in consequence of its being deposited naturally by time or by clarification, is not susceptible of turning sour. I have exposed old wine in uncorked bottles to the ardour of the sun of July and August for more than forty days without the wine losing its quality; only the colouring principle was constantly precipitated under the form of a membrane, which covered the bottom of the bottle. The same wine in which I infused vine-leaves, became sour in a few days. It is known that old wines, well purified, do not turn sour.

4th, Wine does not acidify, or become sour, but when in contact with the air: atmospheric air mixed with wine is a real leaven of acidity. When wine grows flat (*se pousse*) it suffers to escape, or exhales, the gas it contains, and the external air then enters to assume its place.

Rozier proposes to adapt a bladder to a pipe inserted in the vessel, in order to ascertain the absorption of the air and the disengagement of the gas. When the bladder fills, the wine tends to flatten; if it empties itself, it is a sign of its turning sour.

When wine flattens, the cask suffers the wine to ooze through the sides, and if a hole be made with a gimblet, the wine escapes with a hissing noise and foam: on the other hand, when wine turns sour, the sides of the cask, the bung, and the luting, are dry, and the air rushes in with violence as soon as it is unstopped.

From this circumstance it may be concluded that wine shut up in very close vessels is not susceptible of becoming sour.

5th, There are certain times of the year when the wine turns more readily sour. These periods are, the moment when the sap rises in the vine, when it flowers, or when the grapes assume a reddish tint. It is during these periods, in particular, that precautions must be taken to prevent its becoming acid.

6th, Change in the temperature also promotes acidity, especially when the heat rises to 80 or 90 degrees. The degeneration is then rapid, and almost unavoidable.

The acidity of wine may be easily prevented by removing all those causes before mentioned which tend to produce this alteration; and when it has begun, it may be remedied by the means, more or less effectual, which we are going to mention.

Baked must, honey, or liquorice, are dissolved in wine in which acidity has manifested itself: by these means its sour taste is corrected, being concealed by the sweetish savour of these ingredients.

The little acid which has been formed may be seized by the means of ashes, alkalies, chalk, lime, and even litharge. This last substance, which forms a very sweet

salt with acetous acid, is exceedingly dangerous. This criminal adulteration may be easily detected by pouring hydro-sulphuret of potash (liver of sulphur) into the wine. There will be immediately formed an abundant and black precipitate. Sulphurated hydrogen gas may also be made to pass through this altered liquor: this will produce a blackish precipitate, which is nothing but sulphuret of lead.

The works of oinologists abound with recipes, of greater or less value, for correcting the acidity of wine.

Bidet says, that about a fiftieth of skimmed milk added to sour wine restores it; and that it may be drawn off in five days.

Others take four ounces of the best wheat, boil it in water till it bursts; and, when it has cooled, put it into a small bag which is immersed in the cask, shaking it with a stick.

Some recommend also the seeds of leeks, fennel, &c.

To show the futility of the greater part of these remedies, it will be sufficient to observe, that it is impossible to make fermentation proceed in a retrograde manner, and that it can at most be suspended; that the whole of the acid then formed may be seized, or its existence may be concealed, by sweet and saccharine principles.

But besides these alterations there are others, which, though less common and dangerous deserve to be noticed. Wine sometimes contracts what is called a taste of the cask. This malady may arise from two causes: first, when the wine is put into casks, the wood of which is rotten or damaged; secondly, when lees have been left to dry in the casks into which new wine is put. Willermoz proposes lime water, carbonic acid, and oxygenated muriatic acid, to correct the bad taste arising from the cask: others recommend mixing the wine with isinglass, drawing it carefully off, and infusing roasted wheat in it for two or three days.

A phænomenon, which has struck and embarrassed the numerous authors who have spoken of the diseases of wine, is what is called the *flowers of wine.* These are formed in casks, but particularly in bottles, in which they occupy the neck; they constantly announce and precede the acid degeneration of wine. They manifest themselves in almost all fermented liquors, and always more or less abundantly according to the quantity of extractive matter existing in the liquor. I have seen them formed in such abundance, in a fermented mixture of molasses and the yeast of beer, that they precipitated themselves in the liquor in pellicles, or numerous and successive strata. In this manner, I have obtained twenty strata.

These flowers, which I at first took for a precipitate of tartar, is, in my opinion, a vegetation, or real *byssus,* which belongs to that fermented substance. It is reduced almost to nothing by desiccation, and by analysis exhibits only a little hydrogen and a great deal of carbon.

All these rudiments or commencements of vegetation, which develope themselves in all cases where an organic matter is decomposed, ought not, in my opinion, to be classed with perfect plants: they are not susceptible of reproduction, and are only a symmetric arrangement of the moleculæ of the matter, which seems rather directed by the simple laws of affinity than those of life. Similar phænomena are observed in all decompositions of organic beings.

In the years 1791 and 1792, the whole product of the vintage was altered at the commencement by an acrid, nauseous odour, which went off after a long-continued fermentation. This effect was owing to an enormous quantity of tree-bugs, (*punaises de bois,*) which had settled on the grapes, and which had been crushed in treading them.

### *VIII. Uses and Virtues of Wine.*

Wine has become the most usual beverage of man, and is, at the same time, the most varied. Wine is known in all climates; and the attraction of this liquor is so strong, that the prohibitory law respecting it, which Mahomet imposed on his followers, is daily broken.

This liquor, besides being a tonic and strengthener, is also more or less nutritive: in every point of view, it must be salutary. The antients ascribed to it the property of strengthening the understanding. Plato, Æschylus, and Solomon, all agree in ascribing to it this virtue. But no writer has better described the real properties of wine than the celebrated Galen, who assigns to each sort its peculiar uses, and describes the difference they acquire by age, climate, &c.

Excess in regard to the use of wine has at all times called forth the censure of legislators. It was customary among the Greeks to prevent intoxication by rubbing their temples and forehead with precious ointments and tonics. The anecedote of that famous legislator, who, to restrain the intemperance of the people, authorized it by an express law, is well known; and we read that Lycurgus caused drunken people to be publicly exhibited, in order to excite a horror of intoxication in Lacedæmonian youth. By a law of Carthage, the use of wine was prohibited in the time of war. Plato interdicted it to young persons below the age of twenty-two. Aristotle did the same to children and nurses. And we are informed by Palmarius that the laws of Rome allowed to priests, or those employed in the sacrifices, but three small glasses of wine at their repasts.

But, notwithstanding the wisdom of laws, the hideous picture of intemperance, and the fatal consequences with which it is attended, the attractions of wine have been so powerful among certain nations, that their fondness for it

has degenerated into a passion and real want. We daily see men, prudent in other respects, gradually acquire the habit of indulging immoderately in the use of this liquor; and in their wine extinguish their moral faculties and their physical strength.

> Narratur et prisci Catonis,
> Sæpe mero incaluisse virtus.

We learn from history, that Wenceslas, king of Bohemia and of the Romans, having come to France to negotiate a treaty with Charles VI. repaired to Rheims in the month of May 1397, where he got intoxicated every day with the wine of the country, choosing rather to forego every thing than not indulge in this excess*.

The virtue of wine differs according to its age. New wine is flatulent, indigestible, and purgative: *mustum flatuosum et concoctu difficile. Unum in se bonum continet, quod alvum emolliat. Vinum rarum infrigidat;—mustum crassi succi est, et frigidi.*

The antients confounded these words—*mustum et novum vinum.* Ovid says, *Qui nova musta bibant. Unde virge musta dicta est pro intacta et novella.*

Light wines only can be drunk before they have grown old. The reason we have mentioned in the preceding pages. The Romans, as we have observed, followed this custom, and drank their wines in succession: *Vinum Gauranum et Albanum, et quæ in Sabinis et in Tuscis nascuntur, et Amienum quod circa Neapolim vicinis collibus gignitur.*

New wines are not at all nourishing, especially those which are aqueous, and little saccharine: *corpori alimentum subgerunt paucissimum,* says Galen.

These wines readily produce intoxication; and the reason of this is, the quantity of carbonic acid with which

* Observations sur l'Agriculture, vol. ii. p. 192.

they are charged. This acid, by disengaging itself from the liquor by the temperature of the stomach, extinguishes the irritability of the organs, and brings on stupor.

Old wines, in general, are tonic, and very wholesome: they are suited to weak stomachs, old people, and in all cases where strengthening is necessary: they afford very little nourishment, because they are deprived of their really nourishing principles, and contain scarcely any other than alcohol.

It is of such wine that the poet speaks, when he says:

> ———— Generosum et lene requiro
> Quod curas abigat, quod cum spe divite manet
> In venas animumque meum, quod verba ministret,
> Quod me, Lucane, juvenem commendet amicæ.

Oily thick wines are the most nourishing. *Pinguia sanguinem augent et nutriunt*;—Galen. The same author recommends the wines of Therea and Scibellia as highly nourishing: *quod crassum utrumque, nigrum et dulce.*

Wines differ also essentially in regard to colour. Red, in general, is more spiritous, lighter, and more digestible: white wine furnishes less alcohol, and is more diuretic and weaker, as it has remained less time in the vat: it is almost always more oily, more nutritive, and more gaseous, than the red.

Pliny admits four shades in the colour of wines—*album, fulvum, sanguineum, rubrum*: but it would be too minute as well as useless to multiply shades, which might become infinite, by extending them from black to white.

Climate, culture, and variety in the processes of fermentation, produce also infinite differences in the qualities and virtues of wine. To avoid fatiguing repetitions, we must refer to what we have already said on this subject.

The art of tempering wine by the addition of one part of water was practised among the antients: wine of this kind they called *vinum dilutum.* Pliny, after Homer, speaks of a wine which could bear twenty parts of water. The same historian informs us, that in his time wines so spiritous were known, that they could not be drunk: *nisi pervincerentur aqua et attenuentur aqua calida.*

The antients, who had very just and correct ideas respecting the art of making and preserving wines, seem to have been unacquainted with that of distilling spirit from them: the first correct ideas respecting the distillation of wine are ascribed to Arnaud de Villeneuve, professor of medicine at Montpellier.

The distillation of wines has given a new value to this production. It has not only furnished a new beverage stronger and incorruptible, but has made known to the arts the real solvent of resins and of aromatic principles, and, at the same time, a mean as simple as certain for preserving animal and vegetable substances from all putrid decomposition. It is on these remarkable properties that the art of the varnisher, the perfumer, the maker of liqueurs, and others founded on the same basis, have been successively established.

## No. 52.

(With a Plate.)

### *A Mode of conveying Intelligence from a reconnoitring party. In a letter from a correspondent, to W. Nicholson, Esq.**

Sir—I herewith send you a model, which I denominate a *Hippograph,* and which appears to me likely to be of use in the march of troops, &c.

It may consist of any number of men and officers, but

* Nicholson, V. 30. p. 126.

I conceive an officer and six men quite sufficient. The use it seems most adapted to is, when a mountain or high ground is in front, and it is wished by the commanding officer to know what may be on the other side, by dispatching such a number of men intelligence can be at once conveyed by changing the front of one or more men to express numbers or permanent signals, as agreed on, as the boards of a telegraph; and by the officer placing himself on either flank, centre, or rear, the numbers would be quadrupled. I know by experience it may be distinguished at a great distance. Should you think this worthy of notice, it will be a satisfaction to, sir, your obedient servant,

H. I. B.

*August*, 1811.

The model consists of little tin casts of six horse soldiers and one officer, see Pl. 12, Fig. 10. These are placed on a slip of wood, and each is moveable on a pivot, so that it may be turned into any position.

## No. 53.

(With a Plate.)

### *Account of a Machine for performing the Thread-Work in Shoe-making in a standing Posture; contrived, and for many Years constantly used by* Thomas Holden, *Shoemaker, of Fettleworth, near Petworth, Sussex.**

A very moderate observation of the different processes of handicraftsmen will shew how extremely various are their habits of manipulating. Every different position of standing, sitting, and, perhaps, lying, may be found among them; and in works apparently of the same na-

* Nicholson, v. 14. p. 155.—For which the Society of Arts gave a premium of fifteen guineas. See vol. xxii. of their Transactions. One of the machines is in their Repository.

Holdens Machine for Shoemakers.

ture, the positions are found to be considerably unlike each other. It is probable that the first workman assumed positions which, whether aukward, confined, or inconsistent with health, or the contrary, came into universal use when the habit of the individual and the confirmed custom of master and apprentice had given them the sanction of many years. Thus we see that men's cloths are sewed by men who sit cross-legged; women's cloths by women who sit in no unusual position: turners in India hold the tool with their feet, and turn the lathe with the left hand, while they sit on the ground with the body leaning very much forward; in Europe they stand and turn with one foot, while the hand directs the tool: comb-cutters, for coarse or open-toothed combs, sit astride a large triangular stool with their work as low as the seat, so that they must keep their bodies almost horizontal while at work; but those who cut ivory combs sit very nearly upright.

Many other examples might be given, not only of works which are practically shewn to be capable of being executed with less injury to the comfort and health of the professors than at present; but of others where the mischiefs are no less evident, and their remedies by no means difficult, if man could be, by the gentle influence of reason, induced to depart from what habit has confirmed and made easy.

The numerous bodily complaints which are consequent to the practice of the art of shoe-making, as now performed, are well known to all; and the remedies in this, as well as other branches of human industry, are intitled to general regard. He who improves the cultivation of the ground, or renders human labour more productive by machinery, is intitled to universal gratitude as a benefactor of the human race: He increases their comforts, and renders the means of subsistence more easy. The same

argument will apply to every man who by his ingenuity or his influence shall diminish the evils which may be ultimately attendant on a life of labour. Thomas Holden has been impelled, for his own personal relief, to construct and use a simple machine for one branch of his craft. The master shoemakers and their masters, or employers, will act meritoriously in extending its use. As the editor of a Journal of *the Arts*, I have thought it my duty in this, as in most other instances, to second the views of that excellent Society, which has been so long established in London, and has so actively and constantly exerted itself for their encouragement.

Mr. Nicholas Turner, who addressed the Society on behalf of this machine, speaking highly in its commendation, says that its cost will not be more than from between twenty and thirty shillings. The inventor himself, after stating his sufferings from the pursuit of his business as a maker of shoes, says that he has found it to answer, and its use to have been followed by a restoration of his health. When he wrote his letter, he had made about two thousand pair of shoes with it, and he considers it as the quickest way of closing all the thread-work.

Certificates were also sent to the Society, from six cordwainers of the vicinity, who were witness to the use and advantages of the machine; and Mr. Peter Martin, Surgeon, of Tulborough, wrote a letter to Charles Taylor, Esq. secretary to the Society, which I have extracted verbatim.

"I am sincerely of opinion, that Thomas Holden's in-
"vention is a desirable acquisition to men of that profes-
"sion, especially to those who may be diseased internal-
"ly, or who may suffer from stomach weakness and in-
"digestion. These diseases may be aggravated, if not
"occasioned, by their working in a bent posture.

"The inventor, about twenty years ago, often applied

"to me for relief from a train of bowel complaints, and "frequently had occasion to take the medicines usually "employed for the relief of dyspepsia.

"I repeatedly informed him, that his employment was "the cause of his disorder, and desired him to relinquish "it, or invent some method to do his work standing. This "hint, and his corporeal sufferings, prompted to the in-"vention. That it answers the purpose, I have reason "to believe, as he and others use it. He is now free of "complaints, and so improved in his corpulence and "countenance, that he is not like the same man, and for "years has had no occasion for medicine."

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## *Reference to the Engraving of Mr. Holden's Invention for Shoemakers*, Pl. 13, Fig 1.

A. The bed for the closing block, and to lay the shoe in whilst sewing.

B. The closing block.

C. A loose bed to lay the shoe in whilst stitching; the lower part of which is here exhibited reversed, to show how it is placed in the other bed, A.

D. The hollow or upper part of the loose bed C, in which the shoe is laid whilst stitching.

E. A table on which the tools wanted are to be laid.

F. An iron semicircle, fixed to each end of the bed A, to allow the bed to be raised or depressed. This half circle moves in the block G.

H. Another iron semicircle, with notches, which catch upon a tooth in the centre of the block, to hold the bed in any angle required. This semicircle moves sideway on two hooks in staples, at each end of the bed.

I. The tail or stem of the bed A, moving in a cylindrical hole in the pillar, enabling the bed to be turned in any required direction, and which, with the movement F,

enables the operator to place the shoe in any position necessary.

K. The pillar, formed like the pillar of a claw table, excepting the two side legs being in a direct line, and the other leg at a right angle with them.

L. The semicircle H, shown separately, to explain how it is connected with the staples, and how the notches are formed.

M. The tail or stem of the bed A, and the lower part of the bed N, shown separately, to explain how the upper part of the bed is raised or depressed occasionally.

## No. 54.

### *Description of a Machine for the use of Shoemakers. By Mr.* THOMAS PARKER*.

(With a Plate.)

MR. Thomas Parker, the inventor of the machine, was desired to attend with it upon a committee appointed by the Society of Arts, on the 22d of November, 1804, and then informed them, that he had used this apparatus for twelve months past, and found it very useful. That all the work of shoe-making may be done with it standing; but that in some parts thereof he finds an advantage in using along with it a high stool; and that before he used this machine, he never saw or heard of a similar invention; and that he has found it of great service to his health.

He stated the cost of such a machine to be about two guineas.

Plate 13. Fig. 2.——T. A bench standing on four legs, about four feet from the ground.

* Nicholson vol. 15. p. 165.—Communicated to the Society of Arts, who gave a premium of fifteen guineas.

V. A circular cushion affixed to the bench, in the centre of which cushion is an open space quite through the bench, through which hole a leather strap U is brought up from below. This strap holds the work and last firm upon the cushion in any position required, by means of the workman's foot place upon the treadle W.

X, Shows the last upon the cushion, with the strap holding it firm.

Y, An implement used in closing boots.

Z, A small flat leather cushion, useful in adjusting the last and strap.

Fig. 3. The shoe-last shown separate from the cushion. The round cushion is formed of a circular piece of wood, covered with leather or stuffed with wool or hair to give it some elasticity.

## No. 55.

### *Description of an improved File for Receipts and Letters. By* Richard White, *Esq. of Essex-Street*.*

(With a Plate.)

SIR, I send herewith the model of a file for papers, which I think will be found preferable to any in common use. A voucher cannot be disengaged from the common file, without defacing it by cutting it off, or by removing many others to get at it; and to return it to its proper place is attended with more trouble and inconvenience. All this is avoided by the contrivance in the file now sent, the wire of which is passed through a cylinder, and fastened by a screw at the bottom.

I am, Sir, your very humble servant.

RICHARD WHITE.

* Nicholson. v. 25. p. 330.—Transact. of the Society of Arts, vol. xxvii, p. 170. The silver medal was voted to Mr. White for this invention.

### *Explanation of Mr. White's improved Letter File, as shown in Plate* XII, *Figs.* 3, 4, 5, 6,

This invention consists of a metal tube *a*, fig 4, with a convex circular plate soldered to its lower end, to keep the papers from slipping off the file, and having attached to its under side a piece of metal *b*, fig. 5, with a screwed hole in it, to receive a screw on the end of the wire, *c*, fig. 6, the other end of the wire being formed into a hook, sharpened at its point, to receive the papers as usual.

When any paper is wanted to be taken off the file, (instead of taking off those above it, which cannot be replaced again without much loss of time and trouble, or, which is still worse, tearing it off) the uppermost papers are to be slipped up towards the top of the wire *c*, which must be unscrewed, and, with the papers upon it, removed, as shown in fig. 6; the paper wanted may then be taken away, the wire replaced again into its tube *a*, and screwed fast, and the other papers drawn down the tube as before. The upper end of the tube *a* should be made conical, and its edges sharp, the better to suffer the papers to pass over it. A section of the tube and female screw *b* beneath is shown separately at fig. 5. The papers are shown in fig. 3, in the situation they are commonly placed upon the cylinder, with the wire within the cylinder.

## No. 56.

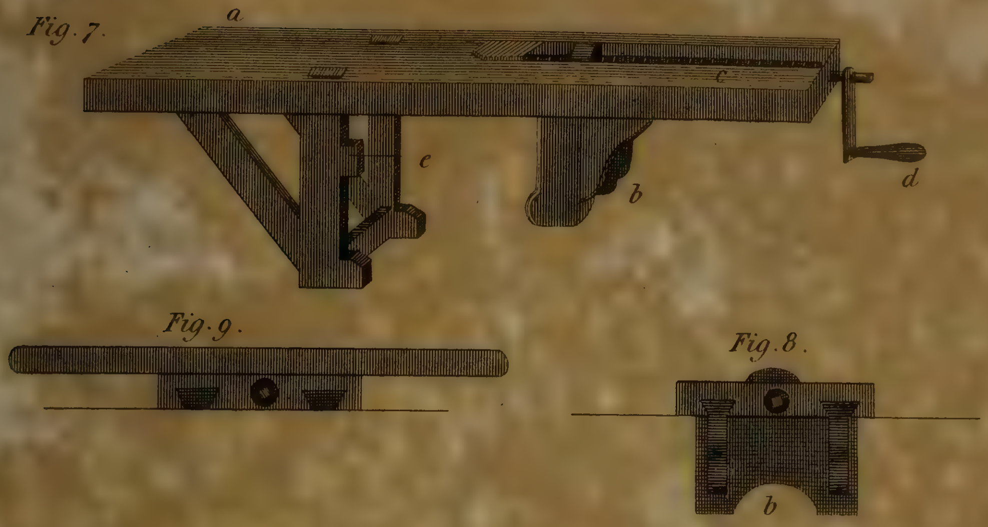
### *Description of Mr.* Davis's *improved Machine for Painters and Glaziers*.*

(With a Plate.)

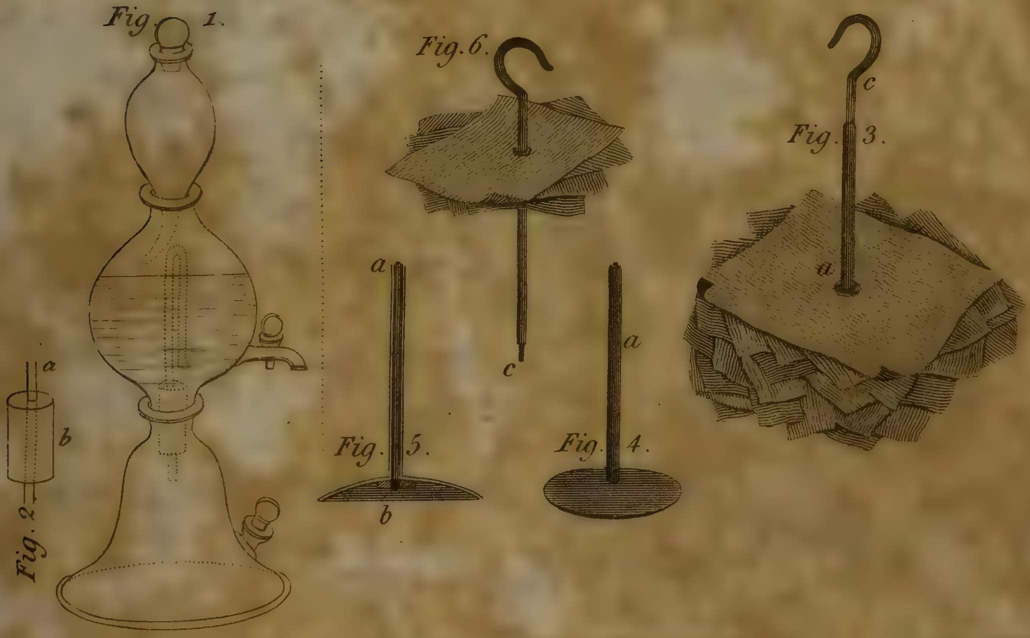
THE frequent accidents which happen to painters and glaziers, from the unsteadiness of their machines, and the

* Nicholson v. 19. p. 13.—From the Trans. of the Society of Arts for 1806, p. 138.

## Davis' Machine for Glaziers.




## Whites' improved Letter File.




## Hippograph.

Fig. 10.

consequent misery brought upon their families, stimulated Mr. Joseph Davis, of the Crescent, Kingsland Road, to endeavour at their improvement. The result was the machine delineated in Plate 12, which may be made perfectly firm and secure, without occasioning any injury to the wainscoting or paint. In those cases however, where the bottoms of the windows are flush with the floor, as is usual in the best apartments of modern houses, neither the common machine, nor this with the improvement intended for general use, can be applied: but Mr Davis has contrived an additional piece to be used on such occasions, which renders it equally secure.

Fig. 7, Plate 12, Represents the machine: the part *a* is similar to that used by glaziers, which is placed on the outside of the window. *b*, is an additional moving piece, which presses against the inside of the window frame, and is brought nearer to, or removed farther from it, by means of the male screw *c*, and its handle *d*.

Fig. 8, Shows the lower part of a window, and the manner in which the moving piece *b*, including a female screw, acts against the inside of the window frame.

Fig. 9, Shows a cross bar introduced in place of the moving piece last mentioned, which bar extends from one window side to the other, and explains how the machine may be used, where any injury might arise from screwing the moving piece in the centre of the recess of the window.

The general improvement consists in the use of a screw on that end of the frame which is within the house, and which keeps the machine steady and firm, instead of the two upright irons, which are put through holes made in the top plank of the machine, in the coommon mode, and which occasion the machine to be very unsteady in use, and liable to accident. There are two blocks marked *e*, *e*, in Fig. 4, which may be occasionally put in, or taken out, according as the stone work under the window may require.

## No. 57.

## *Agenda, or a Collection of Observations and Researches, the Results of which may serve as the Foundation for a Theory of the Earth. By* M. De Saussure.

(Concluded from page 343.)

### CHAP. XXI.

### *Researches to be made in regard to the Loadstone.*

1. THE theory of the loadstone ought to form a part of the theory of the earth, because the phenomena which depend on it belong to the whole globe; and because Halley, and after him other philosophers, have endeavoured to explain the different phenomena of the magnet by supposing the earth to be hollow, and that it contains in its cavity one or more magnetic globes.

2. In considering the loadstone it ought first to be examined whether, in order to explain its phenomena, we ought, like Descartes, to suppose a close fluid moving in a vortex around the magnet, and entering at one of its poles and issuing at the other: or, as M. Æpinus, a discrete fluid, susceptible of rarefaction and condensation, which is rarefied in one of the poles and condensed in the other; or, lastly, as M. Prevost*, two fluids, susceptible of being combined with each other in such a manner that one of them alone is acccumulated around the north pole of a magnet, while the other is accumulated around the south pole; and that all the magnetic phenomena may be explained by the elective attractions which these fluids exercise either upon each other or on iron†.

* De l'origine des forces magnétiques, 8. Geneve 1788.

† The celebrated Coulomb admits also two fluids, which compose the magnetic fluid, and which exercise their action in the inverse ratio of the square of the distance: but, in the theory of phenomena connected with the action of the globe, this philosopher sets out from certain facts immediately given by observation; one of which it would be of importance to verify in different points of the globe. This fact is, that the forces which attract one of the poles of a magnetic needle

3. It must then be examined, whether the direction of the magnetic needle, and its inclination, depend on the situation of a large magnet enclosed in the bowels of the earth, as Halley supposes; or on the action of one of these two magnetic fluids towards one of the poles, and, perhaps, of the other fluid towards the opposite pole, as M. Prevost supposes.

4. If we admit the hypothesis of a large magnet suspended within the cavity of the earth, shall we suppose, as the inventor of this hypothesis, that this magnet has four poles? Or, shall we endeavour to explain the whole, as that great geometer Euler has done, by a magnet having only two poles? Or, lastly, shall we suppose, as Mr. Churchman, an American philosopher, has lately done, that the earth contains two magnetic poles, one at the north and the other at the south at different distances from the poles of the earth, which perform their revolutions in different times; and that, from the combined influence of these two poles, we may conclude the annual changes of the declination with so much precision, that we can deduce the longitude of any place from its latitude, and from the degree of declination which the needle experiences.*

5. Thus, by supposing one or more magnets in the interior part of the earth, the annual changes of the declination and inclination may be explained by the rotary

freely suspended towards the north, are equal to those which attract the opposite pole towards the south. Coulomb concludes that this equality exists, because a needle, weighed two different times, before and after it was magnetised, was found exactly of the same weight.

C. Borda has found, by observations made first at Brest, Cadiz, Teneriffe, Goree on the coast of Africa, and afterwards at Brest and Guadaloupe, that the intensity of the force exercised by the globe on the magnetic needle, estimated according to the number of oscillations made by the needle in a given time, was sensibly the same in these different places. This observation in other latitudes, especially on approaching the poles, might throw some light on the theory of natural magnetism.—Note of C. Hauy.

* Heads of Lectures by S. Priestley, London 1794.

movements of these magnets. But in the system, which does not admit these internal magnets, it is asked, Whether the changes of declination might not depend on movements which produce the change of obliquity, precession, nutation, and perhaps other phenomena or inequalities of that kind.†

6. With regard to diurnal variations, an English philosopher, Mr. Canton, considering that it is proved by experience that heat diminishes the force of the magnet, thought that the solar rays, by heating the earth, must lessen the attractive force of the grand magnet contained in it; and he thence deduced, as will be seen hereafter, an explanation of these variations. But Mr. Canton did not reflect on what was clearly seen by M. Æpinus, that this magnet, if it exists, is sunk to too great a depth in the earth for the action of the solar rays, or at least the variations of that action, in the morning and evening, to be able to penetrate to it. We may, however, apply to the ferruginous minerals, dispersed in abundance over the surface of the earth, what Mr. Canton supposed, in regard to the grand magnet contained in its bosom; and then, if we admit that these minerals exercise any action on the

† Æpinus gives another explanation independent of these movements. It may be possible, according to this philosopher, that the declination of the magnetic needle arises, in general, from the irregular figure of the nucleus of the magnetic globe, or from an unequal distribution of the fluid in its interior part: and to account for the variation of this declination in one place, in the course of time we might suppose that the figure of the nucleus, or the distribution of the fluid it contains, is itself variable. Æpinus presumes also, that the action of the iron-mines dispersed throughout the bosom of the globe, may have an influence on the variation in question; and may, perhaps, be the sole cause of it. *Tentamen theoriæ electr. et magnet.* p. 268, 271, 334.

This philosopher wishes that men of science, who have an opportunity of being near a mine of loadstone, would determine, by observation, whether the masses of this mineral, before they are taken from the bowels of the earth, have their poles disposed, in regard to the poles of the world, like those of needles freely suspended: and whether, in certain masses, the poles are not in an inverse direction, of which he shews the possibility by means of consequent points. *Ibid.* p. 333.—Note of the same.

magnetic needle, we cannot deny that the heat, excited by the rays of the sun, may diminish that action. From these principles it would follow, that in the morning, when the sun warms the surface of the ground situated to the east of the needle, the latter, being less strongly attracted towards that part, ought to decline towards the west; and, for a contrary reason, it must in the evening decline towards the east. But Mr. Canton proved, by a long series of observations, that at London, at least, this is the ordinary course of the diurnal variations.

7. But it will be proper to examine whether this explanation, even thus corrected, does not contain a paralogism; and when the attractive force of all the ferruginous particles, dispersed over the surface of the earth, to the east of the needle, is diminished equally and simultaneously, the needle ought not to remain motionless; since the diminution of the attraction exercised upon the south-pole of the needle, compensates for the diminution of that exercised upon the north-pole.* I say the same thing of those situated to the west. If this reasoning be just, the needle ought not to vary by the action of the solar heat, but when this heat diminishes the magnetic force of the ferruginous parts situated to the north of the needle, more than that of the parts situated to the south, or reciprocally.

* Let O be the centre of suspension of the needle N. S., and *a*, *b*, *c*, *d*, the forces which attract the needle in opposite directions; for example, pieces of iron. The forces in *b* and *d* conspire to make the extremity N of the needle move towards the west; and the forces at *a* and *c* conspire in the like manner to make the same extremity proceed towards the east. When the needle remains at rest, there is an equilibrium, and the forces $a+c=b+d$. But in this supposition, if the forces of the same side, *b* and *c* for example, gradually diminish, the equilibrium will not be interrupted. For, let $b=y+m$ and $c=z+m$: if the forces *b* and *c* are equally diminished by the quantity *m*, we shall always have $a+z=b+y$. The case will be the same with any augmentation, if it be equal and simultaneous on all the sides of the needle. —Note of the Author.

East.

$$\begin{array}{ccccc} a & & & & d \\ \mathrm{N}\ ) & \!\!-\!\!-\!\!-\!\! & \mathrm{O} & \!\!-\!\!-\!\!-\!\! & (\ \mathrm{S} \\ b & & & & c \end{array}$$

West.

To determine this curious question, it would be necessary to make choice of two opposite coasts, and directed almost east and west from the magnetic meridian; such as the coast of Provence to the south, and that of Normandy to the north; to establish two compasses well suspended, such as those of M. Coulomb, one to the south, at Antibes for example, and the other to the north, near Cape de La Hogue; and to see whether their diurnal variations did not proceed in a contrary direction: that is to say, whether that at Antibes, having the continent to the north, and only sea to the south, would not decline, in the morning, towards the west, as that of Mr. Canton did; and whether that of La Hogue, having the continent to the south and sea to the north, would not, at the same time, decline to the east. Mr. Canton, indeed, who made these observations at London, had, to the north of his magnetic horizon, the greater part of England and all Ireland; and thus he must have had the variation west in the morning and east in the evening, as he observed it; for it is certain that the sea preserves the land, which it covers, from the action of the sun; and that thus the attraction of that land ought not to vary by the heat which emanates from that luminary.

By carefully repeating and varying these observations, in places chosen with discernment, we shall be able to decide whether the regular diurnal variation depends upon a general cause, the action of which, however, is susceptible of being suspended or disturbed by local causes; or whether we are to believe, on the contrary, as M. Van Swinden does, that the diurnal variation is not a cosmic phenomenon, or that it does not depend on a general cause inherent in the globe, and which every where acts according to the same law.

9. Is there properly any action of the magnetic fluid on the electric fluid? or is there, between these two fluids,

only a resemblance of properties, or in their manner of action?

10. Is it well ascertained, as M. Van Swinden thinks, that the *aurora borealis* acts on the magnetic needle; and can any idea be formed of the mode of this action?

11. The same question in regard to the zodiacal light.

12. In general, the theory of the magnet is still so far from perfection, even in that part which depends merely on observation, that it is much to be wished that observers and observations were multiplied, especially in what concerns the inclination of the needle. In regard to the declination and its variations, M. Van Swinden has given a noble example of correctness, and of constancy in observations, and in the art of classing and comparing the results. It would be of great benefit if this example were followed in different situations and climates. It would be highly interesting, for instance, to determine, with precision, the zones of the earth where the declination is nothing, and where changes take place, and the same for the inclination.

## CHAP. XXII.

### *Errors to be avoided in Observations respecting Geology.*

1. THERE are some errors into which people may readily fall when they have not had long experience in any given kind of observation, and against which it is of importance to put beginners at least on their guard.

2. One may be readily deceived in regard to the relative distances of remote objects. All the stars and planets appear to be at an equal distance from us. Distant mountains all appear to be in the same plain. Thus those which are situated very far behind the rest, seem to form one body with them; so that people believe they see continued and uninterrupted chains when there are

really none, and where the mountains, on the contrary, are insulated.

The absolute distance of objects, even when not very remote, is equally difficult to be ascertained on high mountains, where the transparency of the air, and the absence of vapours, destroy the aërial perspective. I have often imagined that I had only two or three hundred steps to make in order to reach a summit, the distance of which from me was more than a league in a straight line.

3. There are a great many errors in regard to strata. Their great thickness may make one believe that there are none where they really exist. In the like manner, if the vertical strata, or those only very much inclined, present their planes to the eye of the observer, he will think he sees shapeless and indivisible masses; while, if their sections were seen, their divisions would readily be distinguished. A mountain then must be seen under aspects that intersect each other at right angles before we can pronounce that it is not divided by strata.

4. At other times accidental fissures, but produced however by a cause which is common to them, exhibit the appearance of strata when there are none: or when, if there are, their situation is very different from that of those strata. It is the internal tissue of the stone only which in many cases can determine whether the divisions observed are the interstices between strata or mere fissures; because the strata are constantly parallel to the internal laminæ, or schistous texture of the stone. Crystals, the lamellated texture of which may sometimes be confounded with a schistous texture, may afford an exception to this rule, by presenting laminæ perpendicular to the planes of the strata; but it is not difficult to distinguish them.

5. One may also form an erroneous opinion respecting

the direction of a mountain, or of its strata, when the eye is not situated in their prolongation, or at least near it.

6. The apparent situation of the strata may also lead into an error. They appear horizontal even when they are very much inclined, and when they are not seen but in a section formed by a plane parallel to the common section of their planes with the horizon. It is impossible to judge of their inclination, and to measure it with certainty, but on a section perpendicular to the common section, which I have just mentioned.

6. A. The greatest error, however, is that which may be committed in regard to the super-position of strata. I have often seen novices in the study of mountains believe that one stratum reposed on another; one of granite, for example, on one of slate; because they found slate at the bottom of the mountain, and granite at the top; while the slate was only laid against the base of the mountain, and the granite, on the other hand, was sunk in the earth far below the slate. We must not then say, that a stratum is situated below another, but when we really see it extending itself below it.

7. And even when we distinctly see a rock placed above another, we must examine whether that which is uppermost does not occupy that situation accidentally; whether it has not slipped, or rolled down, from a more elevated mountain; and, in the last place, though they may be closely connected, one must examine whether their present situation is really the same in which they were formed, and whether they have not been reversed, and united accidentally in a situation contrary to that of their original formation.

8. One is frequently deceived, also, in regard to the nature of stones and of mountains. Though a well-accustomed eye may often judge at some, and even a considerable distance, of the kind of stone of which a moun-

tain is composed, such judgment is however often erroneous: mountains of granite, or *gneiss*, tender and destructible, often assume, at a distance, the round form of secondary mountains; sometimes, also, mountains of calcareous stone, hard of their kind, and in strata either vertical or very much inclined, present the bold forms, the peaks, and sharp-angled indentations of the granite summits.

9. People are often deceived even on a near view. A stone may have a foreign covering of mica, for example, while the interior part is of a very different nature.

10. Effervescence with the nitrous acid is commonly considered as a certain character of calcareous stone; but this character may be deceptive, since barytes and magnesia effervesce also:* and we must not consider it enough to touch a stone with the nitrous acid, or to let fall a drop of the acid on its surface, since the absorbing earth, whatever it is, may be only disseminated between argillaceous or siliceous particles. We must therefore immerse a fragment of the stone in a quantity of the acid sufficient to dissolve it entirely, if it be wholly soluble, and observe whether there remains any residuum that withstands solution.

11. The action of the air and of meteors often gives fossils appearances absolutely different from those which they had before they were subjected to it. We must not then be satisfied with a superficial examination: we must sound the rocks to the quick where the action of meteoric agents has not penetrated.

12. People are often deceived, also, in considering compound stones as simple stones, when the composition of them does not manifest itself on the first view, either on account of the smallness of their composing parts, or be-

* And, on the other hand, there are calcareous stones which do not effervesce.

cause some of these parts are each inclosed separately in a covering which conceals the interior of them. One may guard against this error by observing the fossil in the sun with strong magnifying glasses, after having moistened its surface with water or the nitrous acid, and still better by exposing it gradually to the flame of the blow-pipe.

13. People are often deceived in regard to crystallisation, either in the true form of the crystals, or, above all, in taking for real crystals parasite crystals, or such as have been formed in the moulds made by crystals of another kind. Thus we see crystals of quartz, petro-silex, and jasper, formed in the moulds made by calcareous crystals, and which have assumed the form of the latter.

14. In regard to errors occasioned by ignorance of the distinctive characters of fossils, and of the names proper for them, the only means of avoiding such errors is to study with care good authors; and, above all, collections formed, or at least arranged and titled, by able mineralogists.

15. But when the slightest doubt is entertained in regard to the denomination which ought to be given to any fossil, an exact description must be made either of its external characters or its most striking physical properties, such as weight and solubility.* If this description is well drawn up, the error respecting the name may be rectified, and the observation will not be lost, as it would be were there any reason to suspect the justness of the denomination, and no means of correcting it by a description.†

* Hardness, refrangibility, electricity, &c. H.

† A person now dead, who in his time was considered as a mineralogist, wrote to me that he had found marine shells in granite. I begged him to give me an exact description of the stone which he called *granite*. He did so; but I perceived that the stone was a free-stone or sand-stone, and the specimens he afterwards sent me proved that I was not deceived. We may here recollect Re-

16. When the characters of a fossil give it such a likeness to another that it is found near the limits which separate the genera or species of these two fossils, we must follow the example of Werner and his disciples, by marking that this fossil is intermediary, or forms a transition from the one species to the other. For if we should ascribe it exclusively to the genus A, without noting the characters which bring it near to the genus B, another observer, on seeing the same fossil, might refer it to the genus B, and no one could know which of them was deceived.

17. People are often deceived also by mixing opinion with observation, and giving the former for the latter; as when people assert, that they have seen vestiges of extinguished volcanoes, because they have seen black or porous stones, or stones of a prismatic form, without deigning to describe them with care, but by qualifying them merely as *lava* or *basaltes*.

18. In the last place, a very frequent source of error is, too great a confidence in the fidelity of one's memory, or in the justness of one's first observations. These two kinds of confidence go often hand in hand; and people cannot guard against the errors, which are the consequence of them, but by noting down, on the spot, all observations to which any importance is attached, especially if they are a little complex, and carry away specimens, with their characters carefully marked upon them, of the objects that are the subject of these observations; for it is not specimens of rare objects merely that should be collected. The end, indeed, of the geological observer is, not to form a cabinet of curiosities, but he must carry away fragments

cupero's pyrites of Ætna. The errors of this kind, arising from false denominations, are innumerable; for an exact knowledge of mineral substances is more difficult to be obtained, and more rare, than is generally imagined.—Note of the Author.

of things apparently the most common, when an exact determination of their nature may be interesting to theory. People may thus employ, with advantage, the means of confirming or rectifying their first observations, and of making profound researches and comparisons impossible to be made on the spot*.

## CHAP. XXIII.

### *Instruments neccessary for the Geological Traveller.*

1. THE most neccssary instrument is the miner's hammer. It will be requisite to have two, of different sizes: one small, to break small fragments of rolled pebbles, by holding them in the left hand while you strike with the right. Its weight, including the handle, ought to be about ten ounces. The other must be larger, to detach fragments of rock, and to break large pebbles: its weight ought to be quadruple that of the small one. When I travel on horseback, I have these two hammers suspended from the bow of my saddle.

1. A. Two stone-cutter's chisels: one small, of from

* We think it our duty to subjoin here some advice to travellers in regard to the questions which they may ask in the different towns.

Whence do they procure the materials proper for building; such as lime, plaster, tiles, slate, stones of different kinds, and sand? Do they burn turf or coal; and where are they found? Where do they procure their potter's clay, fuller's earth, the clay used for refining sugar, their whetstones and millstones? To observe with what the streets are paved; of what stones the steps of stairs are formed; marks for boundaries, &c.; and to learn from what place they are brought. To ascertain whether wells or the foundation of houses are dug; and whether there are in the neighbourhood any ravines or precipices. These questions will serve to facilitate the means of observing the nature of the ground, by pointing out the natural or artificial excavations that may exist in the neighbourhood, or which ought to be visited. For the same reason it is proper to examine the shores of rivers. It will be of use also to take a general view of the country from the tops of towers and of the highest steeples. It will be of some importance also to enquire, in the country, whether the inhabitants make use of lime, marl, plaster, coal, earth, or turf-ashes, for manuring their land; and from what places these substances are procured. *Til.*

a line to a line and a half, to detach small crystals, or other objects of small bulk; the other, seven or eight lines.

2. To try the hardness of fossils, a piece of steel to strike fire will be necessary; also a triangular file, pretty fine, and a strong bodkin of tempered steel.

3. Nitrous acid, with M. De Morveau's boxes of re-agents.

3. A. An artificial magnet, in a case, with a steel pivot on which it can be placed, to try the magnetism of fossils.

4. A magnifying glass of three inches focus, in order to enable the observer to form a general idea of any fossil: another, of an inch focus, to examine its separated parts; and one of five or six lines for closer examination. These three magnifiers must be always in the traveller's pocket, or ready at hand: but, besides these, he must have, for his closet at home, a microscope furnished with a micrometer.

5. Telescopes, to observe inaccessible mines and distant mountains.

6. A pocket portfolio, with prepared paper for writing on with a pencil of tin solder, which it is not necessary always to cut, and the writing of which is not so easily effaced as that of plumbago. In this portfolio the traveller must write out, on the spot, the sketch of his journal, and insert such observations as occur to him; but he must take the trouble to transcribe these notes at more length, preserving the primitive notes, which will always retain a character of truth, and for that reason people are fond of recurring to them.

7. Some quires of brown paper, a few sheets of which may be carried in the pocket for wrapping up on the spot specimens of the stones you collect, the characters of which ought to be marked on the cover. You may afterwards

pack them with hay into a bag destined for that purpose, until you have a sufficient quantity to form a box, which you may send home by the public carriages wherever you find an opportunity; but, as it is fatiguing for the traveller to load his pockets during the time of his excursions, and as the guides often lose them on purpose in order to get rid of them, I have behind my saddle two leathern bags, into which I put them till I come to some halting-place, where I have time to pack them with hay into a bag. M. Besson recommends to those who undertake sea voyages to write with China ink the characters which ought to accompany minerals in long passages, because common ink may be effaced by accidents.

8. A blow-pipe, with its apparatus. As I make much use of this instrument, which at length fatigues me, though I can blow with my cheeks without exercising my breast, I caused to be constructed a pair of portable double bellows, the sides of which contain each sixty-two square inches. These bellows can be suspended from the edge of a table; and I put them in motion by pressing together, between my knees, the two handles, which afterwards separate by the action of the spring. This apparatus may be easily carried, and is very convenient.

9. A graduated semicircle traced out on a copper-plate of a form exactly rectangular, with a plummet suspended from the centre of the semicircle. This semicircle, is the most convenient instrument for measuring the inclination of strata, of veins and declivities; and it may always be carried in a pocket of the portfolio.

10. A compass, furnished with a cross staff, to find the direction of mountains, chains, vallies, and strata.

11. Portable barometers with two mercurial thermometers; one affixed to a barometer to estimate the temperature of the mercury in the latter, and the other with a bare bulb for measuring the temperature of the air. Those

who study meteorology, as well as geology, ought to be furnished also with an hygrometer and an electrometer.

12. For ascertaining the temperature of the sea, at great depths, it will be necessary to have a thermometer constructed like that described in my Travels through the Alps:* for lakes, an apparatus like that pointed out in the note of Section 1399, will be sufficient.

13. Those who understand a little geometry, ought to provide themselves with a sextant, having an artificial horizon, and also a chain, in order that they may be able to measure a base, and thus take the altitude of an inaccessible peak, the breadth of a river, &c. &c. With this sextant they may also find the latitudes. In regard to the longitudes, they require, besides instruments, an expertness in this kind of observation, which cannot be attained but by mariners or professed astronomers.

14. It will be necessary also to have within reach tools for repairing an instrument in case it should happen to be deranged; such as pincers, files, turnscrews, compasses, gimblets, wire, needles, thread, and packthread.

15. Lastly, some good map, pasted on canvas, of the country you propose to examine; and this map ought frequently to be compared with your itinerary, and the bearings given by your compass.

16. In regard to the care required for the traveller's person, he must have a light dress made of cloth, without lining, of a white colour, as well as his hat, that he may be less exposed to the heat of the sun's rays; with jackets, some cool for the warm regions and the vallies, and the other warm for the cool regions and eminences; a good great coat; green spectacles, and a black crape, to secure the eyes and face from the snow. Lastly, if he is to pass the night in the open air, a tent or *cannoniere,* a bear's skin to sleep upon, and woollen blankets.

* Section 1392, Plate 1, fig. 3

17. A solid light walking-pole: mine for the high Alps is a young fir-plant, extremely dry, seven feet in length and 18 lines in diameter at the lower end, which is shod with iron tapering to a strong point. These dimensions may appear large, but nothing can be too strong for the steep rocks, glaciers and snow, when you are obliged to take your point of support at a distance from you, and to rest the whole weight of your body on your pole, by holding it in a situation very much inclined, and even horizontal, as may be seen in the Vignette to the First Volume of my Travels through the Alps.—For mountains which are not so steep, the traveller may be satisfied with poles of less strength and size; but it will still be necessary that they should be four or five feet in height, and sufficiently strong that a person might be able to support himself with his two hands by holding them in a horizontal situation, according to the attitude of the small figure which is on the left side at top of the before-mentioned vignette; for, in traversing or descending a rapid declivity, or in walking on the margin or edge of a precipice, the traveller must always support himself by his two hands, holding the pole towards the mountain, and not towards the precipice, as those do who have not learned the art of travelling through mountains.

18. To prevent slipping on the hard snow-ice, and grass-plats, which are still more dangerous, I would recommend iron cramps, such as those which I have caused to be engraved in the third plate of the first volume, and which I have long used with success. In my last excursions, however, I preferred shoes, the thick soles of which were armed with strong tacks, at the distance of eight or nine lines from each other. The heads of these tacks are of steel, and shaped like a square pyramid: I have some small ones, the points of which are only two lines and a half in height, and of about the same breadth, for the

snow-rocks and grass-plats; and others, of double these dimensions, for the hard snow.

19. In the last place, with regard to provisions, when the traveller must reside for a considerable time in the desarts, at a distance from habitations, and even huts, he may carry with him some salt or pickled meat; but M. Parmentier's saloop of potatoes, with cakes of portable soup, and bread, will form the most nourishing food, and what may be contained in the least room. A small iron chaffing-dish, a small bag filled with charcoal, and a pan of tinned copper or iron, form my kitchen apparatus for the mountains: wooden plates and spoons may be found in the remotest huts. It will be proper, however, to carry always in the pocket a cup of gum elastic, in order that the traveller may at all times easily quench his thirst, a want to which, he will be frequently exposed in his excursions.

From what has been said, it may be readily seen, that the study of geology will not suit the indolent or sensual; for the life of the geologue must be divided between fatiguing and perilous journies, in which he is deprived of almost all the conveniences of life, and the varied and deep researches of the closet. But what is still more rare, and perhaps more necessary than the zeal requisite to surmount these obstacles, is, a mind free from prejudice, filled with an ardent desire for the truth alone, rather than with a desire for raising or destroying systems; capable of descending to minute details indispensibly necessary for the correctness and certainty of observations, and of rising to grand views and general conceptions. Those fond of such studies, ought not, however, to be discouraged by these difficulties; there is no traveller who may not make some good observation, and bring with him at least one stone worthy of being employed in the construction of this grand edifice. It is indeed possible to be use-

ful without attaining to perfection; for I have no doubt that if the mineralogical travels, even the most esteemed, and much more those of the author, be compared with these Agenda, there will be found in them many deficiencies, and many observations, either imperfect, or even totally forgotten: but I have mentioned the reason in the Introduction. Besides, several of these ideas did not occur till I had finished my travels; and for that reason I laboured with more zeal on these Agenda, in the hope of rendering young persons, on their entering this career, capable of performing what cost me thirty-six years of travelling and study.

## No. 58.

### *List of American Patents.*

(Continued from Page 396).

1803.

Simeon Rouse, Jan. 1. Improvement in the caboose of a vessel for distilling fresh from salt water.

Gurdon F. Saltonstall, Jan. 4. A saw mill for cleaning cotton.

Christopher Hoxie, Jan. 7, machine for hulling rice.

Thomas Moore, Jan. 27, refrigerator for domestic uses.

J. Moffat, Feb. 1, boiler for accelerating the evaporation of liquids.

John Moffat, Feb. 1, improvement in stills.

Benjamin Cooley, Feb. 1, machine for raising water.

Jedediah Peasly, Feb. 1, manufacturing marle into lime.

Christopher J. Hütter, Feb. 11, making brandy out of all kinds of grain or fruit.

Moses Coats, Feb. 14, machine for paring apples.

Abel Stowel, Feb. 14, improvement in a gauge auger.

Elisha Bartlett, Oliver Bartlett, Otis Bartlett, and George Bartlett, Feb. 17, a machine for making hot wrought nails.

William Bell and John S. D. Montmollin, March 7, improvement to their patented roller cotton gin.

John Naylor, March 7, improvement in extracting a spirit from starch water.

Silas Bent, March 7, a wheel to turn under water.

John Baptiste Aveilhé, March 16, a horizontal wind mill.

Abraham Du Buc Marentille, March 18, a wreck raft.

Abraham Du Buc Marentille, March 18, a sea sitting chair.

John Staples, jun. March 18, a power obtained by the rising and falling of the tide, to give motion to all kinds of machinery.

John Staples, jun. March 18, submarine passage, or hollow inverted arch.

John Cottle, March 21, a machine for cleaning clover seed.

David F. Launay, March 21, an improvement in time pieces.

George Hunter, March 24, improvement in the process of manufacturing sea salt.

Peter De La Beharre, and J. B. M. Picornell, March 24, improvement in the mode of obtaining antiseptick gas.

Edward Marquam, March 28, improved house fan.

Thomas H. Rawson, April 4, antibilious pills.

J. Richardson, April 4, improvement in his evaporating furnace.

W. How, April 6, improvement in a cooler or condenser of vapour.

John Stevens, April 11, improvement in producing steam.

Daniel Brewer, April 22, improvement in a ruling machine.

B. Platt, April 27, improvement in heating and boiling water.

Eliphalet Beebe, April 27, improvement in the mode of constructing vessels with crooked keels.

Matthew Barney, May 4, machine for deepening channels.

William Hopkins, May 13, improvement in building boats.

G. F. Saltonstall, May 14, a rolling machine for cleaning cotton.

Daniel Ilsley, May 14, improvement in distilling spirits.

Richard French, and John T. Hawkins, May 17, improvement in cutting grain and grass.

John J. Hawkins, May 17, improvement in the pentagraph and parallel ruler.

Burgiss Allison, May 17, improvement in the application of the principle of rectifying or improving spirits.

John Clarke, May 19, machine for pumping.

John W. Godfrey, May 25, improvement in working the bellows of a furnace or a forge.

T. Alden jun. May 24, expediting the manufacture of common salt.

Lemuel J. Kilborn, June 4, improvement in the method of distilling or making alcohol.

J. Biddis, T. Bedwell, and W. Mitchell, June 7, improvement in extracting the effective matter contained in barks, &c., for dyeing.

David Morse, June 10, machine for making hinges.

Ezra Corning, jun. June 13, improvement in the manufacturing of hats

Samuel Morey, Rufus Graves, and Giles Richards, June 15, improvement in the steam engine.

I. Tood, A. Day, and W. Bache, June 15, physiognotrace.

Walter Keeler, and James Waring, June 23, a rocking churn.

Benjamin Standring, June 28, a machine for breaking and carding sheep's wool.

L. Stanley, June 25, machine for shearing woollen and other cloths.

Nicholas Young, June 28, machine for pulling hair from skins.

William Ashbridge, June 28, improvement in the construction of iron cabooses.

Robert Heterick, June 30, improvement called the Columbia fire-place.

Samuel S. Camp, July 1, improvement in the mode of applying springs to window sashes.

Samuel Brown, Edward West, and Thomas West, July 8, improvement in distillation, by the application of steam in wooden or other stills.

John Clark and Evan Evans, July 20, machine for packing goods.

David Lownes, July 21, method of cooling liquors.

Do method of securing leaden or other pipes from frost, &c.

D. French, July 25, machine for splitting and shaving shingles.

George Keyser, July 27, improving in a powder mill.

Timothy Kirby, July 28, machine for separating clover seed from the "pod."

Lewis Geanty, Aug. 4, improvement in the construction of sills.

John Baptist Aveilhé, Aug. 24, machine for boring holes in rocks under water.

George Youle, Aug. 25, improvement in a water cock.

George Cleveland, Sept. 9, preparing seals' fur for hats.

Hezekiah Betts, Sept. 13, a wheel press.

John C. Stroebel, Sept. 19, mode of constructing carriages.

Daniel Coit, Oct. 15, family pills.

Lazarus Ruggles, Oct. 18, machine for making wrought nails and brads out of hot rods.

Jedediah T. Turner, Oct. 19, threshing machine.

Gilbert Livingston, Oct. 22, improvement in the construction of the keels of vessels.

Paul Pilsbury, Oct. 25. machine for shelling corn.

William Thornton, Oct. 28, improvement in boilers, also working stills with the same.

Samuel Goodwin, Oct. 31, a horizontal draft wind-mill.

Valentine Cook, Nov. 1, finding salt water and metals. *Bletonism!*

Samuel Cooley, Nov. 12, vegetable elixer, or cough drops.

Enoch Alden, Nov. 15, a dry bellows pump.

Amos Minor, Nov. 16, improvement in spinning wheels.

Asahel E. Paine, Nov. 19, improvement in wind mills.

Jacob Osborn, Nov. 24, improvement in fastening and supporting window sashes.

William Bell, Nov. 24, improvement in the cotton gin.

Do Nov. 25, improvement in the wind-mill.

Do Nov. 25, improvement in propelling boats for inland navigation.

John Fairbanks, Nov. 30, a cylindrick ruler for ruling paper.

Jacob Cist, Dec. 2, improvement in grinding painters' colours, printers' ink, &c.

Jos. Eve, Dec. 6, machine for separating the seed from cotton.

P. Earl, Dec. 6, a twilling machine for pricking leather for cards.

Stephen Seward, Dec. 6, improvement in a fire-engine.

Samuel Rogers and Melville Otis, Dec. 7, machine for rolling plates of iron and cutting them into nails.

James Curtis, jun. Dec. 10, improvement in window springs.

Edward Richardson, Dec. 16, improvement in still heads and condensers.

Joseph Elgar, Dec. 16, improvement in making cold cut nails and brads out of rolled iron.

David Buckman, Dec. 21, improvement in separating clover seed, wheat, &c. from the husk.

John Beverly, Dec. 26, a hydro-mechanical press.

John Selby, Dec. 20, improvement in painting rooms.

Francis Guy, Dec. 30, improvement in making colours for painting, printing, &c.

1804.

Nathaniel Miller and Philip W. Miller, January 5, machine for making brick and tile, by cutting the mortar.

Leonard Beatty, Jan. 19, improvement in stills or boilers.

Thomas Benger Jan. 25, improvement in preparing quercitron or black oak bark for exportation or home consumption, for dying or other uses.

Talmage Ross, Jan. 23, "a double draught fire-place."

William Wigton, Jan. 30, improvement in the construction of stills, and the procees of distilling spirits.

Oliver Evans, Feb. 14, improvement called the screw-mill for breaking and grinding different hard substances.

Oliver Evans, Feb. 14, improvement in steam engines, by the application of a new principle by means of strong boilers to retain and confine the steam, thereby increasing the heat in the water, which increases the elastick power of the steam to a great degree.

John Staples, jun. Feb. 17, improvement in wheels to be moved either by wind or water; for the purpose of giving motion to all kinds of machinery, mills, engines, carriages, ships, boats, &c. &c.

D. S. Dean, Feb. 20, improvement, being a machine for washing clothes, scouring, fulling, and cleansing cloth.

Israel Wood, Feb. 21, "in setting stills and other large kettles."

T. Barnett, Feb. 21, machine for threshing and cleaning grain.

T. Pierce, Feb. 21, improvement being a smut fanning-mill.

W.W. Hopkins, Feb. 24, improvement in hanging window sashes.

Wm. B. Dyer, Feb. 27, "improvement, being a spinning wheel and twisting-mill for the purpose of making cordage.

Jacob Worrell, Feb. 27, a machine for hulling clover seed.

D. M. Miller, March 5, improvement in air or bellows pumps for raising water.

Archibald Robertson, March 5, improvement, being a mode of preparing marble for painting on.

Daniel M. Miller, March 8, improvement in window fastenings, or springs for fastening and supporting sash-lights.

Samuel P. Lord, Jun. March 10, improvement in extinguishing fires in houses, &c.

Moses Smith, March 16, machine for watering cattle.

Ward Gilman, and Wm. Jackson, March 19, improvement in the bedstead, so constructed that it may be taken down and removed by one person, in case of fire, or on other occasions, with much ease and expedition.

Abraham Frost, March 19, machine for preparing what is commonly called top, and swingled tow for paper.

B. Tyler, March 19, improvement being a "wry-fly," which may be applied by wind or water to various machines, viz. grist-mills, hulling-mills, spinning-mills, fulling-mills, paper-mills, and to the use of furnaces, &c.

George W. Robinson, March 24, improvement in manufacturing coat and waist-coat buttons.

J. Williams, March 23, improvement, being an inclined-plane-

statical-wheel machine, for facilitating the passage of boats in canals, or for removing earth, stones, or heavy bodies from hills &c. by the inclined plane.

A. Hunn, March 24, machine for the improvement of navigation.

John Naylor, March 31, "improved still and boiler.

P. Daniel, March 31, improvement in the mode of making shot.

Owen Roberts, April 12, machine for breaking and cleansing flax and hemp.

Calvin Whiting, and Eli Parsons, April 14, improvement in the mode of working sheet tin into different wares.

J. Eaton, April 14, improvement in springs for window sashes.

Michael Garber, April 17, machine for slitting and heading nails.

J. J. Giraud, April 18, double steam-bath still.

P. Goltry, April 24, machine for cleaning flax-seed from cockle, yellow-seed, cheat, and all foul seed, which may be applied to separate wheat, rye, and other grains from each other, and all impurities.

Michael Withers, April 30, machine for shelling clover seed.

Moses Coates and Evan Evans, April 30, improved machine for cutting straw and hay, &c. &c.

Thomas Langstroth, May 1, improvement in paper-mills.

John Stickney, May 1, improvement in the construction of pump-boxes, or pumps, designed for the use of ships of war, merchant vessels, or other purposes where water is required to be raised.

S. Houston, May 3. Columbian threshing, break and cleaning fan.

Levi Stephens, May 8, machine to be fixed to the top of a common churn.

Levi Stephens, May 8, machine for shelling and cleaning corn, which may likewise answer the purpose of grinding tanners' bark, and provender for cattle and horses.

John Staniford, jun. and Amos D. Allen, May 10, improvement of the lantern.

A. D. Allen, May 10, composition for tablets to write or draw on.

Do machine to cut strips or chips of wood to make chip hats, bonnets, &c.

Edward Crafts, jun. May 12, furnace for making pot and pearl ashes, with the manner of using, and the materials of which the same is composed.

E. Weld, May 16, machine, or apparatus for making salt.

Jas. Simons and Jos. M'James, May 17, machine for cleaning and moating cotton after it has been ginned.

Burgiss Allison and Richard French, June 8, machine for making nails and spikes.

Asa Spencer, June 8, improvement in making thimbles.

William Tunstall, June 30, improvement in machines for clearing grain from straw, &c.

B. Folger, July 7, improvement in the mode of pumping and raising water.

Levi Osborn, July 12, improvement in the construction of the fulling mill called the double crank.

John Deaver, July 12, improvement in the plough.

Christopher Hoxie, July 12, improvement in the auger.

Thomas Power, July 12, improvement in the lime-kiln.

C. Veltenair, Aug. 10, metallick grinder, or hone for razors, penknives, scissors, surgeons' instruments, and all kinds of fine-edged tools.

Nicholas Boureau, Aug. 21, improvement in the machine for cutting nails.

Wm. Harrington, Aug. 28, machine for raising water from wells.

Hezekiah Betts, Aug. 29, improved windlass for ships or vessels.

John Roberts, Amos D. Allen, and Ezekiel Kelsey, Sept. 5, machine to cut chips or strips of wood to make chip hats and bonnets, brooms, baskets, sieves, matting, and for various other uses.

Emanuel Kent, Sept. 14, crushing plaster-mill.

Orange Webb, Sept 18, improvement in suspenders.

Richard Weems, Sept. 20, improvement in wind-mills.

J. Bolton, jr. Sept. 29, a wagon, or carriage, to be workedby hand.

John James Thomas, Oct. 2, method to prevent chimneys from admitting water in rainy weather.

Aaron Taylor, Oct. 4, forcing pump to raise water.

Abel Brown, Oct. 17, "the rheumatick liniment" for chronick rheumatism, strains, &c.

Simon Smith, Oct. 23, improvement in gallows, or suspenders, for breeches, pantaloons, or trowsers, &c.

Benjamin Dearborn, Oct. 29, improvement in candlesticks.

Laban Folger, Nov. 1, machine for breaking dough.

D. M'Mullin and T. M. Corby, Nov. 6, machine for cooling and filtering water or other fluids.

David Stodder, Nov. 16, composition, or cement, to prevent the roofs and other parts of houses from taking fire.

John Hooker, Nov. 19, improvement in sash springs.

J. Deneale, Jun. Nov. 20, improvement in the threshing machine.

J. White, Nov. 27, improvement in the oil press.

E. I. Du Pont de Nemours, Nov. 23, machine for granulating gunpowder.

S. Newton, Dec. 22, improvement in the cow or sheep bell.

Frederick W. Geyssenhayer, Dec. 22, machine for cutting nails with, and not across, the grain of the metal.

William Stanton, Jun. Dec. 26, improvement in wind-mills.

Isaac Scott, Dec. 26, "new invented window springs"

Nathan Fobes, Dec. 31, machine for boring gun-barrels.

Joseph Bellows, Jun. and Ebenezer White, Dec. 29, manufacturing ashes.

S. Chamberlaine, Dec. 31, medicine called "bilious cordial."

S. Janes, Dec. 31, mode of improving or setting a horse's ears.

## *List of English Patents.**

1797.

George Hodson, Feb. 23, improved method of separating the fossil or mineral alkali from various substances.

Thomas Oxenham, Feb. 28, portable lever-mangle for calendering linen, &c.

John Silvester, March 9, method of mashing and mixing malt, and all kinds of grain, for the purpose of brewing and distilling.

H. Goodwyn, March 9, mixing and mashing malt, and all kinds of grain used for the purpose of brewing and distilling, by means of an improved mash-tun and mashing-machine.

Wm. Sellars, March 11, machine for drawing out wool or flax, combed by hand, into a perpetual length or sliver, &c.

Wm. Siddon, March 14, method of screwing and fastening the hammer-springs and sear-springs to gun-locks and pistol-locks.

Edmund Bunting, March 25, method of producing a forward and retrograde motion, capable of being applied to mangles, pumps, calenders, rolling-presses, &c.

Robert Barber, March 25, improvement on the machine called a stocking-frame, otherwise the gigger stocking-frame.

Joseph Barton, March 25, preparing indigo for dying wool, silk, linen, cotton, &c.

John Passman, March 25, improvement in machinery for drawing, roving, spinning, wool, hemp, flax, silk, mohair, &c.

* Repertory, vol. viii.

END OF VOLUME FIRST.

William Brown, Printer, Philadelphia.

# CONTENTS.

## Contents.

## *Contents.*



## *The following Engravings occur in this volume.*

# INDEX.

# NOTICE.

HAVING brought to a conclusion, the First Volume of the EMPORIUM OF ARTS AND SCIENCES, the Editor would do injustice to his feelings, were he not to express his gratitude for the uncommon patronage the work has received since the short period of its enunciation. The names which are to be found in the list of subscribers, and which will appear with the termination of the second volume, evince the opinion entertained of the *utility* of such a publication: the estimate of the performance must rest with the public.

It is perhaps necessary to explain to some, who have urged the propriety of more attention to original essays of our own country, that this will never be neglected when important communications are made to the Editor: but whilst so much really valuable matter is to be obtained from foreign sources; it is hoped that no degree of blame will attach to him in rejecting such, which although of domestic origin, in his opinion, may not be worthy of the public eye.—The principal intention of an editor in such a work is to select; to act differently, would be to suppose, that our citizens would encourage, at all events, matter of no importance merely from its being domestic, to the exclusion of what may prove really useful from abroad. It is only necessary again to repeat, that no opportunity will be lost of giving currency to every useful improvement amongst ourselves.

It has been supposed by some, that biographical sketches of the persons whose heads appear in the EMPORIUM, would be highly expedient and proper. To such the editor would submit, that, as

biography does not comport with the intention of the work; inasmuch as it must preclude more useful, because practical matter—so the engravings of such characters are merely added as ornamental additions, to afford the indulgence of a natural inclination to view the features of men, who have in their day and generation given a spring to numerous branches of art and science. As the biography of such men is in general to be found in the Encyclopædia, to it the Editor must refer for details respecting them: and as these portraits will be found not to encroach upon the number of engravings more especially connected with the work, as promised in the prospectus; the Editor requests his subscribers will rather regard them as expressive of the great respect with which he estimates their favourable reception of the work itself; and of the desire he has of making it still more agreeable to them: for they will readily perceive that the proprietor has spared no expence to render it worthy of support; since few works of foreign or domestic origin, will be found to exceed it in the number or execution of those engravings.

It cannot but be evident, that every succeeding volume must render the work more and more useful, by the greater variety of the subjects embraced; as much practical matter has here been introduced as one volume is capable of affording; and it is hoped that a few years, will enable the editor to condense into a small compass, a vast collection of the most important subjects to the United States.

*Philadelphia, October 1st,* 1812.